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ON SOME EFFECTS OF PRIMARY AND SECONDARY ROENTGEN RAYS UPON THE SKIN OF THE FROG TADPOLE

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IN October, 1923, the present authors in collaboration with Mr. C. P. G. Wakeley published an article on the effects of the prolonged action of roentgen rays upon the skin of the frog tadpole.[1] This particular tissue was chosen as it was thought that such a young and rapidly growing structure might give interesting cytological information regarding the action of the radiations. The cytological findings were, however, not of outstanding interest, the main result of the exposure being hyperplastic changes in the epidermis, especially when a trace of colloidal silver was present in the water in which the tadpoles were irradiated. In consequence of this, a further series of experiments was undertaken in which tadpoles were exposed to roentgen rays in the presence of varying concentrations of different colloids, and it is with these that the present communication is mainly concerned.

In order to make the matter as clear as possible it will be necessary here, in the first place, to describe in some detail the structure of the normal tadpole skin, to epitomize our previous findings, and then to describe the histological appearances presented when the animals were exposed to the roentgen rays in the presence of the various colloids.

[1] Colwell, Hector A., Thomson, M. S., and Wakeley, Cecil P. G. The effects of X-rays upon the skin of the frog tadpole. *J. Anatomy, Cambridge*, 1923, lviii, Part I, 21–36.

NORMAL TADPOLE SKIN

As can be seen from Figure 1, the normal tadpole skin consists of a well-marked epidermis with subjacent corium.

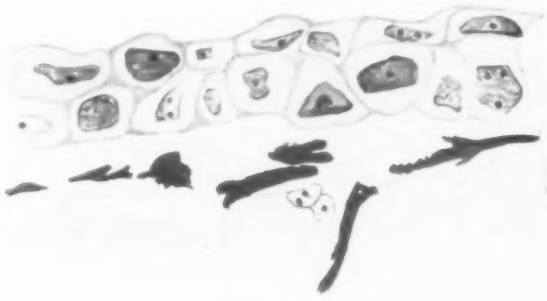

FIG. 1.

Epidermis. The epidermis consists of only two layers of cells. The cells of the superficial layer are somewhat flattened, with more or less oval nuclei. In the deeper layer the cells tend to become more or less polygonal in outline and the nuclei roughly correspond to the shape of the cell.

There is considerable variation in the affinity of the nuclei for the hematoxylin

stain; though generally those of the basal layer stain more deeply than do the nuclei in the superficial layer. It is possible that this apparent difference is due to the fact that the paler nuclei are also the smaller and that they are contained in smaller cells, hence the amount of nucleoplasm is the smaller and the depth of color not so great.

Chromosomes are but rarely seen distinctly: the nuclei, however, are usually particularly well marked. The cytoplasm stains well and exhibits a somewhat clearer area immediately surrounding the nucleus, but no granules or fibrils are present. The cell outlines are extraordinarily well defined, and indeed present many of the appearances of typical cell walls, even to distinct thickenings in the angles between contiguous cells. If there are any intervening lymph channels, they are not demonstrable in any of the specimens examined.

Corium. The corium varies greatly in depth, but it is never so wide as to exceed the width of the epidermis. Its structure is nowhere very obvious, since it stains as a more or less homogeneous pink mass, although a meshwork of white fibrous tissue and a network of elastic fibers can be somewhat indistinctly seen. In addition, there are also present a few cells which are oval or polygonal in form; the polygonal cells give off many fine branching fibrils and their nuclei are large with well-defined nucleoli.

It is, however, the pigment cells which form the most characteristic feature of the corium. These lie deeply and in close apposition to the subjacent muscle bundles: they show considerable variation in size and shape and are generally markedly arborescent. Comparatively few of these arborescent processes are seen to penetrate between the muscle bundles, and practically none are seen between the epidermal cells. The pigment cells are extremely friable, and small masses of pigment are often seen scattered over the whole area of a section. That this appearance is due to rupture of the pigment cells during the processes of preparing and cutting the sections may be assumed from the fact that these scattered granules are in all cases very small, and that they are seen superimposed on all tissues and even apparently lying in the lumen of the gut, when a section across the whole body of the tadpole is examined.

In all cases where more gross injury has occurred it is seen that the epidermis is torn away as a whole, while the corium with its pigment cells remains attached to the deeper structures.

Throughout the experiments an ordinary Coolidge tube and induction coil in use in the therapeutic department of King's College Hospital were employed. Variations in the conditions of working were made in different groups of experiments and will be found duly noted in their appropriate places.

The tadpoles were exposed in circular flat-bottomed glass dishes, and the distance of the anticathode from the surface of the liquid was varied according to the conditions of the experiment.

GROUP I

Tadpoles irradiated in ordinary tap water. Coolidge tube working at about 2 milliamperes with a 7-inch spark gap. Distance of anticathode from surface of liquid 6½ inches; depth of liquid in glass dishes 1½ inches in the first series (Series A).

Series A. In this series, as stated above, the depth of water was in each case approximately 1½ inches, and the tadpoles were divided into three batches irradiated for periods of one and a half, two and five hours respectively. Individuals were killed at varying periods after irradiation, fixed in 50 per cent alcohol, dehydrated, cleared, embedded in paraffin and sections cut in the ordinary way. The stain employed was hematoxylin and eosin.

The conditions occurring in the epidermis as the result of exposure to the roentgen rays are shown in Table 1. The *one and a half hour* and *five hour* specimens form a fairly comparable series; unfortunately the *two hour* specimens died off suddenly after the first observations had been made, but still the specimens we were able to examine showed some features of interest.

Specimens Killed Immediately after Exposure. Here it will be seen (Table 1) that while the *one and a half hour* specimens

TABLE 1

SHOWING THE CHANGES OBSERVABLE IN THE EPIDERMIS IN SPECIMENS KILLED AT DIFFERENT PERIODS AFTER EXPOSURE TO ROENTGEN RAYS FOR ONE AND ONE-HALF, TWO AND FIVE HOURS RESPECTIVELY

Time After Exposure at Which Specimen Was Killed	Tadpoles Irradiated 1½ Hours	Tadpoles Irradiated 2 Hours	Tadpoles Irradiated 5 Hours
Immediately	No change except in a very few localized areas in the thinnest part of the tail, where the cells are larger and the nuclei appear more active than in the normal. No hyperplasia.	Slight but definite local hyperplasia. No attempt at syncytium formation. Some perinuclear vacuolation.	A few patches of hyperplasia, chiefly in the basal cells. All cell outlines indistinct. In some cases nuclei are fragmented. The nuclei are smaller than normal and stain irregularly.
24 hours	Many small areas show very active nuclear division with local loss of definition of cell outline. No definite hyperplasia, but all distinction between superficial and deep layers is lost.	Basal cells show hyperplasia with some syncytium formation. In places there is very definite invasion of the corium.	By far the greatest part of the epidermis is narrow, shrunken and attenuated. All distinction between superficial and deep layers is lost. Nuclei generally small and stain well. There are, however, some areas which are devoid of nuclei and present a homogeneous stretch of protoplasm.
27½ hours (specimen died)	In one area the nuclei show great activity. The cell outlines are lost and there is syncytium formation with definite invasion of the corium.		
48 hours	Cytoplasm generally shows some vacuolation. Numerous areas of hyperplasia with syncytium formation and invasion of the corium.		General picture is one of degeneration, although there are a few areas where hyperplasia is also occurring. Epithelium generally narrowed; nuclei in some cases absent, in others irregular and fragmented.
72 hours			The most striking feature is a combination of hyperplasia and degeneration. Hyperplastic areas adjoin areas of degeneration where there are no cell outlines and only fragments of nuclei remain.
84 hours	Appearances much as in the 48-hour specimen (*see above*). Hyperplasia is, however, more marked and there is some exfoliation of many new superficial cells. These are small and consist of a nucleus with only a thin layer of cytoplasm. No degenerative changes seen, but the cells give a general impression of being smaller and less active than in the 48-hour specimen (*see above*).		
96 hours			Complete epithelial degeneration. In many cases a thin structureless thread is all that represents the epithelium; but occasionally a few living basal nuclei can be seen.
7 days (specimen died)	Complete atrophy of the epidermis, which is represented merely by a wavy line with a few small local thickenings. The line consists of an evenly stained strip which has taken up the eosin and hematoxylin equally and so presents a homogeneous lilac strip.		

show very little change—and that limited to isolated patches of what suggests only increased nuclear activity—the *two hour* specimens already show areas of slight but definite hyperplasia. The *five hour* specimens although exhibiting areas of local hyperplasia nevertheless present mainly features of all degeneration as evinced by the fragmentation of the nuclei.

FIG. 2.

Specimens Killed Twenty-four Hours after Exposure. Here again the *two hour* specimens occupy a position intermediate between the *one and a half hour* and the *five hour* specimens; for while the *one and a half hour* specimens exhibit marked nuclear activity and a loss of demarcation between the superficial and deep layers of the epidermis, the *two hour* specimens show hyperplasia with local syncytium formation, in which the cell outlines are completely lost, together with quite definite invasion of the corium.

In the *five hour* specimens, on the contrary, the appearances are practically entirely degenerative in character, although traces of temporarily increased activity are here and there recognizable.

One of the *one and a half hour* tadpoles was found as it was actually dying; it was transferred to the fixing agent, and on subsequent examination the epithelial cells were found to exhibit marked signs of activity with syncytium formation and definite invasion of the corium (27½ hours after exposure—see Table 1).

What we have termed "syncytium formation" is very characteristic of the hyperplastic changes which occur in the tadpole epidermis as a sequel to irradiation. The nuclei exhibit signs of active division, but the cell outlines (which in the normal epidermis are so marked as to suggest the presence of definite cell walls) entirely disappear, and a multinucleated mass of protoplasm results. This multinucleated mass or syncytium shows a marked tendency to the invasion of the subjacent corium. The condition is shown semi-diagrammatically in Figure 3.

A comparison of the subsequent changes in the epidermis of the *one and a half hour* and the *five hour* specimens shows (see Table 1) that the *one and a half hour* specimens continue to exhibit increased cell activity with hyperplasia and no obvious degenerative changes up to eighty-four hours after exposure.

The *five hour* specimens, on the other hand, show degenerative changes immediately after exposure, although small isolated patches of hyperplasia occur coterminously with areas of marked degeneration. These sporadic areas of hyperplasia have, however, completely disappeared in specimens examined ninety-six hours after exposure. Here there is complete epithelial degeneration; the epidermis being represented only by a narrow structureless

FIG. 3.

thread, while here and there an occasional basal nucleus can still be demonstrated.

This is in marked contrast to the *one and a half hour* specimen examined eighty-four hours after irradiation (see Table 1). Here the hyperplastic changes are still the predominant feature, although the appearances suggest that perhaps the limit of stimulative reaction has been reached.

A further example of the *one and a half hour* specimens examined seven days after exposure to roentgen rays shows com-

pletely atrophic changes, corresponding fairly closely to those seen in the *five hour* specimen only ninety-six hours after exposure (Fig. 4).

From a consideration of these specimens it is clear that irradiation for one and one-half to two hours gives rise to a temporary hyperplasia without obvious coincident early degeneration. Exposure for five hours, on the other hand, while producing hyperplastic changes which can be detected immediately after exposure, nevertheless also gives rise to degenerative changes which are obvious from the first and soon come to dominate the picture, until in ninety-six hours after irradiation the condition has become one of pure atrophy.

In the case of the corium in this series, the changes are not so easy to distinguish. The most obvious occur in the large pigment cells. These tend to become rounded and to lose their arborescent processes under the influence of the radiations; subsequently they become fragmented and the pigment is scattered throughout the corium as fine dust-like granules. In the *one and a half hour* specimens this fragmentation has not made its appearance in the example taken eighty-four hours after exposure, but in the *five hour* series was already obvious seventy-two hours after exposure, and in ninety-six hours this fragmentation was complete and the pigment scattered in the form of minute granules. A similar picture is shown in an example of the *one and a half hour* series taken seven days after exposure.

Series B. Conditions as in Group 1, *Series A, except that the tadpoles were exposed in dishes containing water to the depth of about* ½ *inch instead of* 1½ *inches.*

This series of observations was made as the tadpoles during their period of exposure have a tendency to remain at the bottom of the vessel, with the result that in a depth of 1½ inches of water appreciable screening effects,due to the superficial layer of water, might occur from the softest rays of the mixed beam. Accordingly some specimens were exposed in dishes with about ½ inch of water. These exposures were in all cases made for a period of five hours, the water being changed at intervals of about twenty minutes during the exposure.

As regards the epithelium no essential difference was observed between the animals exposed in 1½ inches of water and those exposed in ½ inch; except that perhaps in the latter case the effects were slightly more marked and appeared somewhat earlier than in the former.

But in the case of the corium, it is in the specimens irradiated for five hours in ½

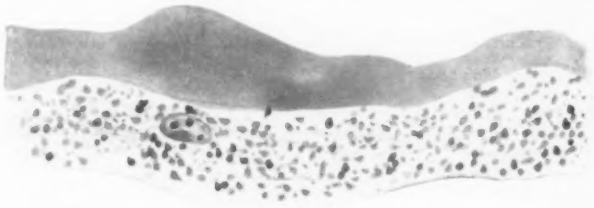

Fig. 4.

inch of water that we first meet with definite changes apart from those occurring in the pigment cells. In specimens examined immediately after such an exposure the fibrous tissue exhibits signs of fragmentation and the elastic fibers are seen to be short and twisted.

Similar appearances occurred in specimens examined twenty-four hours later.

In specimens examined after forty-eight hours the destructive changes are found to have progressed. The connective tissue is torn away from the basal epithelial layer of the epidermis, while the bundles of white fibrous tissue are broken, swollen and edematous. The connective tissue cells are large and rounded, with pale indistinct nuclei, and show a complete absence of all processes.

A comparison showing the effects produced by five hours' irradiation in 1½ and ½ inch of water respectively is set forth in Table II.

The pigment cells in both series (*i.e.*, those exposed in 1½ inches and those exposed in ½ inch of water) show at first a tendency to become ovoid and to lose their processes. Fragmentation with scattering of the pigment as fine granules, however, occurs sooner in Series B (*i.e.*, those exposed in ½ inch of water) than in Series A (exposed in 1½ inches).

To Sum Up: Irradiation of tadpoles in ordinary water for one and a half hours results in temporary hyperplastic changes

TABLE II

SHOWING THE DIFFERENCE OBSERVABLE WHEN THE TADPOLES WERE EXPOSED IN 1½ INCHES AND ½ INCH OF WATER

Time after Exposure at Which Specimens were Killed	Depth of Water 1½ Inches	Depth of Water ½ Inch
	Epithelium	
Immediately	A few patches of hyperplasia, chiefly in the basal cells. All cell outlines are indistinct. In some cases nuclei fragmented. Nuclei generally smaller than normal, and stain irregularly.	A few patches of hyperplasia. Nuclei in some cases smaller than normal. Cells distinctly outlined and in places separated from one another.
24 hours	Epithelium narrow, shrunken, attenuated. Distinction between superficial and deep layers lost. Nuclei generally small and stain well. Some areas devoid of nuclei appear as homogeneous stretch of protoplasm.	Epithelium very friable, easily detached from corium, and showing a few patches of hyperplasia. Nuclei all small; mostly stain only faintly, and in many cases fragmentation has occurred.
48 hours	The general picture is one of degeneration, although there are a few areas where hyperplasia is still occurring. Epithelium narrowed; nuclei in some cases absent, in others irregular or fragmented.	Epithelial cells shrunken and protoplasm contracted around the small nuclei. Large swollen cells with very pale and indistinct nuclei, separated from each other and friable, these apparently represent degenerating areas of hyperplasia.
	Corium	
Immediately	Pigment cells lying immediately below basal cells of epithelium; they form medium-sized horizontal masses with little tendency to arborization.	Pigment cells form large spheroidal clumps. Very few arborescent figures seen. *The fibrous tissue is broken up and the elastic fibers are short and twisted.* Connective tissue cells unchanged.
24 hours	Pigment cells ovoid. No sign of arborization.	Appearances as in previous specimen.
48 hours	Pigment cells ovoid. No arborization.	Connective tissue torn away from basal epithelial layers, and the bundles of white fibrous tissue are swollen and edematous. Connective cells large and rounded with pale indistinct nuclei and complete absence of all processes. All pigment cells totally disintegrated, pigment scattered as fine granules throughout the corium.
72 hours	Pigment cells show commencing fragmentation.	
96 hours	Marked fragmentation of all pigment cells. Pigment scattered as fine granules throughout the corium.	

in the epithelium, with a certain amount of syncytium formation. Nuclear activity is seen to be increased in specimens examined immediately after exposure. The hyperplastic changes are best marked in from forty-eight to eighty-four hours after irradiation, but in seven days there is complete atrophy of the epidermis.

Specimens irradiated for two hours show traces of commencing hyperplasia immediately after exposure; but in those exposed for five hours although hyperplasia is evident immediately after irradiation, degenerative changes have also made their appearance and continue to increase so that in four days after the exposure complete epithelial atrophy has occurred.

GROUP II

Condition as before, but with a small quantity of protargol solution added to the water so that the total concentration was about 0.04 *per cent. Depth of liquid* 1½ *inches.*

This experiment was carried out in order to ascertain whether the secondary radiations produced by the presence of colloidal silver had any special action which could be demonstrated by microscopic examination. The exposures were made for two hours.

As a control some tadpoles were placed in the dilute protargol for two hours and were not subjected to any radiations. On examining them microscopically no deviations from the normal were observed.

Specimens Examined Immediately after Exposure. All the cells appear small and rather shrunken, but signs of hyperplasia are present, both in the epithelium and in the connective tissue.

exposing the tadpoles to the roentgen rays in ordinary water.

Now it is well known that different substances when exposed to roentgen rays give off secondary radiations which are *characteristic* as regards their wave length for the particular substance used. Moreover these characteristic rays have definite relations to the atomic number (or the number indicating the position of the element in the periodic series) and consequently to the atomic weight. It was accordingly determined to carry out a series of experiments in which different colloidal elements were added to the water in which the tadpoles were exposed, in order to see if the secondary radiations from other elements produced

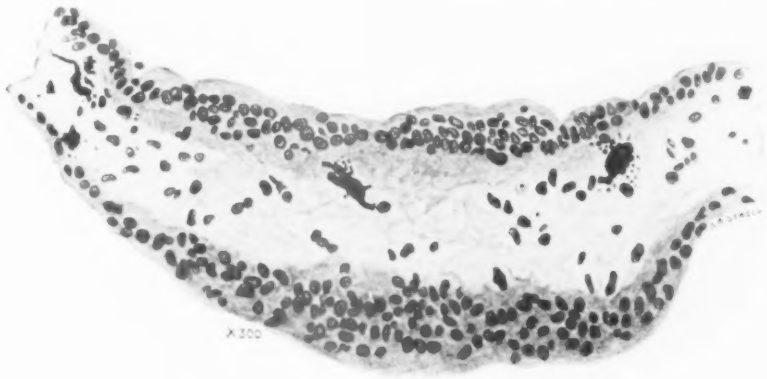

Fig. 5.

Specimens Examined Forty-eight Hours after Exposure. In these specimens hyperplasia of the epithelial cells has occurred to a much greater extent than in any hitherto examined. The epithelium generally is increased to about five cells in thickness and sometimes more. This hyperactivity is moreover pretty constant over the whole of the skin, and is not limited to more or less isolated patches. The cell outlines are frequently obliterated. Corresponding activity is seen in the connective tissue cells of the corium, which also exhibit a marked tendency to branching, while the pigment cells are small and markedly arborescent (Fig. 5).

From this it is clear that the secondary rays from the added protargol solution have had a very definite and marked effect in accentuating the hyperplastic changes which we have seen to be an early result of the same effect as those from silver. The colloids used were those employed for ordinary therapeutic purposes and were kindly furnished to us by the Crookes Laboratories. In all cases the concentration of the stock colloid which was added to the water was 1 in 2,000. Needless to say, owing to the extremely fine state of subdivision of the colloidal elements, these sols afford a most convenient method for obtaining the characteristic secondary radiations of the element present in colloidal form.

GROUP III

Tadpoles irradiated for 1½ hours in water to which small amounts of different colloids have been added. In each case the anticathode of the Coolidge tube was 12 inches rom the surface of the liquid. The depth of the liquid throughout the experiments was approximately ½ inch.

Colloidal preparations of six elements were used in this series of experiments, the concentration of each original stock solution being 1 in 2,000. The sols employed were those of copper, selenium, silver, gold, lead and bismuth. The atomic numbers and atomic weights of these elements are as follows:

TABLE III

	Atomic Number	Atomic Weight
Copper	29	63.5
Selenium	34	79.2
Silver	47	108.0
Gold	79	197.2
Lead	82	207.0
Bismuth	83	209.0

appeared to have a marked effect in producing epithelial hypertrophy in the frog tadpole, it was next decided to experiment with the secondary rays from other bodies to see if they caused effects in any way resembling those of the secondary rays from silver.

The substances selected were chosen as covering a fairly wide field of atomic numbers (29 to 83), and moreover as they are prepared on a commercial scale as sols of standard concentration for therapeutic purposes they were extremely convenient to use.

Sometimes the mixture of sol and water appeared to have toxic effects before irradiation was commenced. This was noticeably the case when 10 per cent of

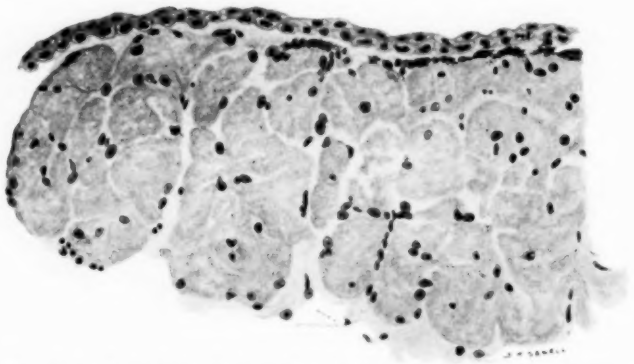

FIG. 6. Drawing of section of normal tadpole skin, showing subjacent muscle.

As already mentioned, when a suitable beam of roentgen rays strikes different elements, secondary roentgen rays are produced which, as regards their wave length are as characteristic for the element in question as are the lines seen in a visible spectrum when certain substances are sufficiently heated. Moreover the wave lengths of the characteristic secondary roentgen rays have been found to bear definite relations to the atomic number; in fact, corresponding groups of lines in the characteristic groups of lines of the different elements have wave lengths which are an inverse function of the square of the atomic number. Hence rays in the characteristic spectrum of copper will have longer wave lengths than corresponding rays in the characteristic spectra of selenium and other elements of higher atomic number.

As we had seen in our preliminary observations that the secondary rays from silver

the "collosol" gold was added to water. On immersing the tadpoles in the mixture they appeared to be in a dying condition after about five minutes: indeed in three minutes they were noticed to be swimming about in a series of spasmodic jerks, after which they became sluggish and floated on their sides. On removal to fresh water they recovered in about half an hour and were swimming in an apparently normal manner.

The copper and silver mixtures (containing 10 per cent of the collosol) were also toxic in their action and several specimens died as a result of immersion; sufficient, however, survived to enable observations to be made, and although at the end of one and a half hours' irradiation they appeared to be dead, yet on transference to fresh water they revived. The 10 per cent mixture of gold sol and water was, however, found to be too toxic to allow of the specimens being kept in it for the one and

a half hours' irradiation. A 50 per cent mixture was, however, found to be of a sufficiently low toxicity to admit of the necessary exposure, and subsequently a series of tadpoles were exposed in a 1 per cent mixture of the collosol* in water.

For convenience of reference it may be advisable to group the specimens which have already been considered and those which have yet to be considered, as under:

Group I. Tadpoles irradiated in ordinary water. Surface of water 6½ inches from anticathode.

Series A. Depth of water in which tadpoles were exposed, 1½ inches.

Series B. Depth of water in which tadpoles were exposed, ½ inch.

Group II. Tadpoles irradiated in water to which 0.04 per cent of protargol had been added. Surface of liquid 6½ inches from anticathode. Depth of liquid 1½ inches.

Group III. Tadpoles irradiated in water to which small amounts of different "collosols" (concentration 1 in 2,000) had been added. In all cases the anticathode was† 12 inches from the surface of the liquid (as distinct from 6½ inches in Groups I and II). Depth of liquid about ½ inch in all cases.

Series C. Concentration of "collosol" in water 10 per cent.

Series D. Concentration of "collosol" in water 5 per cent.

Series E. Concentration of "collosol" in water 1 per cent.

Group III. *Series C. Tadpoles irradiated in water to which 10 per cent of "collosol" had been added. Coolidge tube, 7-inch spark gap. Anticathode 12 inches from surface of liquid. Depth of liquid about ½ inch.*

The times after exposure at which specimens were examined are shown in the accompanying schedule.

Table IV

Copper	Selenium	Silver	Lead	Bismuth
72 hours	72 hours	72 hours	.....	.....
.....	96 hours	.....	96 hours	96 hours
17 days	17 days	17 days	16 days	16 days

*"Collosol" is the proprietary name of the standard sols repared for therapeutic purposes by the Crookes Laboratories, Chenies Street, London. Those used by us had a uniform concentration of 1 in 2,000; and for experimental purposes 10 c.c., 5 c.c., or 1 c.c., were added to 90, 95, or 99 c.c. of water. The actual quantity of colloidal substance used throughout these experiments was obviously very minute.

† Throughout Group III the surface of the liquid was 12 inches from the anticathode as distinct from the 6½ inches in Groups I and II. With the increased distance it was not found necessary to change the liquid during the exposure.

The results of irradiation in the presence of the various colloids are as follows:

SPECIMENS EXAMINED SEVENTY-TWO HOURS AFTER EXPOSURE

(Copper, Selenium, Silver)

Copper. These specimens show only slight deviations from the normal. Such changes as they are, tend towards atrophy and there is no suggestion of hyperplasia. There is some vacuolation, particularly in the cells of the basal layer of the epidermis, and in these particular cells the nuclei are somewhat shrunken and distorted.

Selenium. The superficial layer shows shrinkage of the cells, with small nuclei in the greater part of the sections. There are, however, some small patches of hyperplasia. In these situations the cells are more cuboidal, though in some the nuclei appear small and shrunken, while in others they are larger and obviously active. Nevertheless even in these areas the cytoplasm shows signs of cloudy swelling and vacuolation.

Among the cells of the basal layer the degenerative changes are more distinct; some are shrunken while others, although large, show definite vacuolation, and the nuclei are small and irregular in shape. In the hyperplastic areas the nuclei are large and active with distinct chromosomes and nucleoli, but vacuolation has occurred in the cytoplasm of the cells.

Thus although some hyperplastic areas are present, they are few in number, and the cells have already undergone degenerative changes similar to those seen in the rest of the epithelium. The hyperplastic areas are more numerous on the limbs (Fig. 8).

Silver. The superficial epidermal layer shows no sign of vacuolation. In some areas the epithelium is increased to four cells in thickness, and of these the outer three tend to be flattened although they are distinctly irregular in outline. The cells of the basal layer retain their normal cuboidal form. The nuclei are large and appear active, while the nucleoli are very distinct.

The basal layer presents occasional cells which have swollen and distorted nuclei and vacuolated cytoplasm. In the areas of hyperplasia, however, the nuclei are well

formed and active-looking. There is no evidence of invasion of the deeper tissues.

In those parts of the same tadpoles where the cross section of the body is less the epithelial hyperplasia is more general and more marked. For example, the whole of the epidermis around the leg is increased to about five cells in thickness; and here the outer layer of cells stains definitely pink and shows striation as though some attempt at keratin formation was taking place.

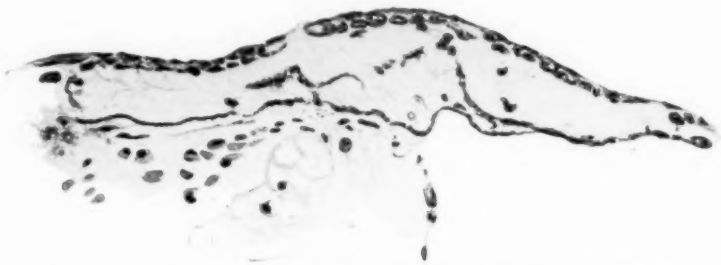

FIG. 7. Drawing of section of tadpole skin seventy-two hours after irradiation in presence of colloidal copper. Note the degenerative changes in the epidermis.

SPECIMENS EXAMINED NINETY-SIX HOURS AFTER EXPOSURE

(*Selenium, Lead, Bismuth*)

Selenium. Extensive vacuolation of the epithelial cells is the predominant feature. Although occasionally shrunken and distorted, nuclei are present in all cells, and many are large and obviously active. Particularly is this the case in the small and infrequent patches of hyperplasia. The superficial cell layer contains much finely granular pigment, and a few clumped chromocytes are seen below the basal epithelial layer. Most of them, however, lie over the subjacent muscles and are apparently normal.

Lead. Degenerative changes are the most marked feature in the epidermis of these tadpoles. While small nuclei, vacuolation and occasional cell shrinkage are predominant, the last is sometimes so marked as to lessen the depth of the skin to half the normal. But even in these thinned areas the nuclei can be distinguished. Here and there, the nuclei of the basal layer are large and apparently active, although no actual hyperplasia has occurred. The connective tissue cells of the corium are all very distinct and show no evidence of degeneration. Much finely granular pigment is present in the cells of the epidermis, particularly in those of the outer layer. Many of the chromocytes are contracted into spheroidal masses lying superficially in the true skin, while the remainder are elongated, flattened, and have very few processes.

FIG. 8. Drawing of section of tadpole skin examined seventy-two hours after irradiation in presence of colloidal selenium.

Bismuth. The greater part of the skin shows degenerative changes in both layers

of epithelium and in the corium. The cells have small degenerated nuclei and a moderate amount of vacuolation. The basal layer is less severely affected than is the superficial, frequently showing strips in which the nuclei are large and active, but there is no sign of hyperplasia. There is a good deal of finely granular pigment, particularly in the cells of the superficial layer. Occasional spheroidal chromocytes are present in the epithelium, while the remainder of the pigment is seen as a thin dark line lying on the deeper structures. No arborization is seen; indeed early disintegration seems to be in progress, for many of the pigment cells have indistinct outlines and are surrounded by minute granules.

SPECIMENS EXAMINED SIXTEEN OR SEVENTEEN DAYS AFTER EXPOSURE

(*Copper* (17), *Selenium* (17), *Silver* (17), *Lead* (16), *Bismuth* (16))

Copper (17 *Days*). Two distinct phenomena are observable in these specimens. There are some *occasional* patches of hyperplasia which, although affecting a relatively large skin area are themselves only a few cells in depth. In these areas all the epithelial cells are cuboidal, with large nuclei. Were it not for their position, it would be impossible to distinguish them morphologically from those of the basal layer. Beneath the epithelium the connective tissue cells appear to be degenerated; their cytoplasm is swollen, and in places several cells appear to have coalesced, where their protoplasm much resembles a smear of mucus. The nuclei throughout are small, faintly stained and in places show well-marked disintegration.

The pigment cells are all seen as a thin black line lying deeply on the underlying muscles.

But by far the greater part of the skin shows no epithelial increase. Most of the superficial cells are shrunken, and either show no nuclei, or, if these are present they are small and distorted. The basal layer demonstrates considerable vacuolation in the cytoplasm, but less nuclear degeneration. In some places the degeneration has progressed to such an extent that the cytoplasm of both layers of the epidermis has coalesced and stains as a homogeneous mass with occasional suggestions of degenerated nuclei.

Most of the pigment lies deeply, but a good deal is lying between the epithelial cells. Apparently the greater the degree of degeneration, the greater is the amount of pigment present in the epithelium.

Selenium (17 *Days*). The specimens are very similar to the last, but areas of hyperplasia occur more frequently. They consist of patches, three or four cells in depth; but even here degeneration has commenced, and there is vacuolation, shrinkage and distortion of cells together with loss of nuclei.

Throughout the rest of the skin atrophy is the most obvious feature. The whole epithelium is thinned; and the cells having shrunk and lost their clear outline, it is frequently impossible to distinguish between superficial and deep epithelial layers. Poorly stained, disintegrating nuclei and occasional vacuolation complete the picture.

The connective tissue of the corium appears to have undergone similar changes of hyperplasia with subsequent degeneration. The pigment cells show changes corresponding to those noted in the preceding (copper) series. Where degeneration is most marked, most pigment is present in the epithelium. The remainder of the chromophores lie deeply and form spherical masses with no sign of arborization or activity.

Silver (17 *Days*). The most striking features in these specimens are well illustrated in the accompanying figure. There are patches of such well-marked epithelial hyperplasia that they practically amount to excrescences. In them all differentiation between the two epidermal layers is absolutely lost. The cells are large and cuboidal or oval. Their nuclei are large, stain well and have more distinct chromosomes and nucleoli than have hitherto been noted in any of the specimens examined, and in some definite mitosis can be seen (Fig. 9).

There are two outstanding phenomena in these hyperplastic areas.

The first is the presence of elliptical cells, with no obvious nucleus, and yet containing a rounded, more faintly staining body.

They are very suggestive of Paget cells and therefore of early malignancy. This, too, in spite of the fact that nowhere is there any definite sign of downward growth and invasion of the corium.

The second figure is, however, the more striking. There are many dark brown bodies contained within the cells; these assume a curious digitate appearance, or they resemble barbed arrow-heads. The former is the more characteristic, and its mode of formation may be deduced by reason of the cell noted as (A) in the figure. In this cell the protoplasm immediately surrounding the nucleus is seen to contain a very finely divided pigmentary deposit, while the protoplasm itself has assumed a figure somewhat reminiscent of an aurora borealis. There is a "dusty" area immediately surrounding the nucleus, and from this central body radiating "fingers" emerge. Between this stage and the finished brown figure there can be detected many intermediate forms. It would thus seem that this curious shape is due to a "scaffolding" formed by the protoplasm, and is not caused by any characteristic crystallization of the silver. That this deposit is silver, and not melanin has been proved in other sections by the photographic processes of bleaching one with potassium ferricyanide and sodium thiosulphate. Slight "development" was obtained with hydroquinone and "intensification" with mercuric chloride followed by ammonia.

In the corium there is little apparent change. The pigment cells are mostly present as a continuous line lying deeply in the muscles, and while many cells are "clumped" the majority show distinct arborization. This arborization is best seen in those chromocytes which lie in the epidermis, where many intercellular fibrils can be seen.

Lead (16 *Days*). Degeneration is here extremely marked; frequently the skin is seen as an attenuated strip with only an occasional nucleus. The greater part merely shows small cells, the nuclei shrunken or absent, and areas of vacuolation. Here and there a very little hyperplasia can be recognized in the basal layer, but even here degenerative changes have supervened.

Similar changes have overtaken the chromocytes. While much pigment is present in the epithelium, particularly in the superficial layer, the greater part is contained in cells lying in close apposition to the basal layer of the epidermis. These cells are flattened, have no processes, are more transparent than normal, and are surrounded by a cloud of minute granules. The connective tissue cells are few in number, with but little cytoplasm and small nuclei.

FIG. 9. Drawing of section showing marked epithelial hypertrophy seventeen days after irradiation in the presence of colloidal silver.

Bismuth (16 *Days*). The appearances are similar to, but less marked than those of the preceding (lead, 16 days) specimens. There are more areas of hyperplasia, and in these areas degeneration does not seem to have occurred. In other areas also many of the epithelial nuclei are large and have well-marked chromosomes. The chromosomes show some degenerative changes but they are less marked than in the "lead, 16 days" specimens. Many are present as spheroidal bodies in the epithelium but they do not show any signs of fragmentation.

The broad results, as regards the epithelium, of irradiating tadpoles in 10 per cent

TABLE V

SHOWING CHANGES IN EPITHELIUM AS A RESULT OF IRRADIATION IN 10 PER CENT COLLOSOL FOR ONE AND ONE-HALF HOURS

Group III. Series C

Time after Exposure	Copper	Selenium	Silver	Lead	Bismuth
72 hours.....	Degeneration marked. No hyperplasia	Mainly marked degeneration. A few small areas of hyperplasia.	Hyperplasia		
96 hours.....	.....	Degeneration: though a few small hyperplastic areas can still be seen.	.....	Degeneration. No hyperplasia.	Degeneration. No hyperplasia.
16 or 17 days...	(17 days) Degeneration is the dominant feature. A few hyperplastic areas are still seen.	(17 days) Marked degeneration and atrophy. The hyperplastic areas are more numerous and better preserved than in the corresponding copper specimens.	Enormous hypertrophy.	Degeneration is the prominent feature. The small hyperplastic areas have undergone degeneration.	Degeneration is the prominent feature. Occasional areas of hyperplasia. Changes rather less marked than in the corresponding lead specimens.

collosol mixtures may conveniently be epitomized in tabular form (Table v).

Thus it appears that in the present series (Group III, Series C), specimens irradiated in the presence of copper showed the maximum of degenerative change; in the presence of selenium atrophy, though prominent, was associated with somewhat more hyperplasia than the "copper" specimens; in the presence of silver, hypertrophic changes were predominant, while with lead and bismuth degeneration is the prevailing condition and the changes are less marked with bismuth than with lead. Small hyperplastic areas occasionally occur in the later lead and bismuth specimens.

GROUP III. *Series D. Tadpoles irradiated as in previous Series (C), but in presence of 5 per cent collosol instead of 10 per cent.*

The times after exposure at which different specimens were examined are shown in the accompanying schedule:

TABLE VI

Copper	Selenium	Gold	Lead	Bismuth
.....	.....	48 hours	48 hours	48 hours
8 days	8 days	8 days	.....	.....
20 days	20 days	20 days	20 days	20 days

SPECIMENS EXAMINED FORTY-EIGHT HOURS AFTER EXPOSURE

(Gold, Lead, Bismuth)

Gold. The outer structure of epidermal cells is flattened, while the inner layer shows a good deal of vacuolation. While this applies to the greater part of the body of the tadpole, very different changes can be seen in the limbs and tail where the cross section of tissue is much smaller. Here there are areas which show great thickening of the epidermis and the cell outlines are lost. The nuclei in these patches are large and deeply stained with well-marked nuclei and chromosomes, but there is no sign of invasion of the deeper tissues. Here and there further changes have occurred in the hypertrophic areas. Towards the periphery some nuclei are obviously degenerating, while the cytoplasm is apparently undergoing transformation into keratin, for the outermost layers show striation and are stained pink, with complete absence of nuclei. In these more degenerate areas pigmentary changes have occurred. There are dark brown sickle-shaped bodies in some of the cells, and actual strata of the same pigment laid down in some of the keratinized areas.

The changes indeed are somewhat similar to those seen in the seventeen day silver specimen (Group III, Series C).

Lead. The superficial epithelial cells are often small and degenerated, often containing no obvious nuclei; there is occasional vacuolation but this is more common in the basal layer. A few areas of basal hyperplasia are seen, where the nuclei are large and active and show occasional mitotic figures.

While some pigment is present in the superficial layer of the epidermis, the majority of the chromocytes lie deeply and show little tendency to arborescence.

Bismuth. The picture presented by these specimens is a slight exaggeration of the preceding. There are similar degenerative changes in the epithelium and the hyperplastic areas are a little more marked. Some of the chromocytes lie quite deeply between the muscle bundles, but there is a considerable amount of pigment in the outer epithelial cells and also immediately below the basal layer.

SPECIMENS EXAMINED EIGHT DAYS AFTER EXPOSURE

(*Copper, Selenium, Gold*)

Copper. The picture is pre-eminently one of atrophy. The whole of the epithelial cells are shrunken and distorted and it is often impossible to distinguish between basal and superficial layers. While some nuclei, here and there, are very obvious, in that they have distinct chromosomes and nuclei, the majority can be but faintly discerned. In some of the cells the cytoplasm is closely adherent to the nucleus; in others fragmentation of the whole of the cell contents is marked. While the greater part of the epithelium is thus represented by a thin unevenly stained layer, there are a very few areas in which the two strata are more distinct and where there is also a suggestion of slight hyperplasia, in that three rows of nuclei are sometimes discernible. But even here degeneration has occurred, so that it is impossible to say with certainty that hyperplasia has preceded the degenerative changes.

In the subcutaneous connective tissue similar changes have taken place and only an occasional nucleus is seen.

The pigment is mostly contained in deeply lying chromocytes which form a thin line covering the deeper structures. There is, however, some pigment in the epithelium and its presence is most marked where the atrophy is most extreme. Occasionally it is so dense in these regions that it is impossible to distinguish the cell nuclei.

Selenium. The most obvious change is that of vacuolation in all the epithelial cells. There is very little shrinkage and no loss of nuclei, although many are somewhat distorted. Hyperplasia with slight increase in the thickness of the epithelium has occurred in places. In these situations there is no degeneration, but there is also no syncytium formation and no invasion of deeper structures. The connective tissue of the corium appears to be normal; the chromocytes are mostly deep in position and show arborization, though some are spheroidal and lie in the epidermis.

Gold. Generally the picture is one of slight degeneration, but in the tails hyperplasia has occurred and distinction between the two epithelial layers is lost. Keratinization appears to have occurred on the surface, while syncytium formation is evident in the central parts of the hyperplastic areas. There is no invasion of the deeper tissues. Pigment has been extensively laid down in the keratinized cells and there are many fine granules present in the epidermis; most of the pigment, however, is present in the chromocytes which lie deeply on the muscles and present one continuous thin line with no sign of arborization. They are somewhat more transparent than normal and are occasionally surrounded by a fine dust of pigment granules.

SPECIMENS EXAMINED TWENTY DAYS AFTER EXPOSURE

(*Copper, Selenium, Gold, Lead, Bismuth*)

Copper. The picture is entirely one of degeneration. In many cases the two layers of epithelial cells can no longer be distin-

guished. A few nuclear fragments indicate that they have existed, but more frequently there is but one layer of degenerate cytoplasm and nucleoplasm. There are areas suggestive of a previous hyperplasia, but degeneration has taken place, although the nuclei are better preserved than elsewhere. Neither nucleoli nor chromosomes can, however, be distinguished. The chromocytes are present as a thin continuous line lying deeply in the dermis; they are flattened, show no pseudopodia, are more transparent than normal and in many places fragmentation has occurred. The remains of an occasional spheroidal mass in the dermis can be sometimes distinguished. Only a few connective tissue cells and no fibers at all are seen.

Selenium. Degeneration is here again the predominant feature. Extreme vacuolation is seen in the deeper epithelial stratum, where the cytoplasm is contracted closely around the nucleus and lies on the deep cell "wall." The nuclei are generally small and distorted, but occasionally they are absent. Occasionally a large well-formed nucleus is seen in those few areas where a slight hyperplasia has occurred. A small amount of pigment is present in the superficial cells, but more is seen as spheroidal masses in the epithelium. The chromocytes generally form a continuous line deep in the dermis. They do not show arborization but are flattened and somewhat broken up. A few active connective tissue cells, complete with the processes are seen.

Gold. Shrinkage of the epidermal cells with nuclear distortion is most evident, and there is some vacuolation mostly among the deep cells. There are some areas of definite hyperplasia, but this seems to be restricted to the basal layer, where the nuclei are large and definite. Although there is some syncytium formation there is no invasion of the true skin. Much granular pigment is present in the epidermis, but the greater part is present in the deeply seated chromocytes, many of which are fragmented.

Lead. In many places degeneration is so marked that the epidermis seems to consist of but one layer of cells with rather indistinct outlines and but few nuclei. Mostly, however, both layers can be distinguished, though both the cells and their nuclei are shrunken. There are a few areas of definite hyperplasia, and in them the deeper cells have large and active-looking nuclei, while the more superficial cells show degeneration. Much granular pigment is present in the epidermis. The chromocytes all lie deeply and are flattened and more transparent than normal. Arborization is absent and definite fragmentation is taking place.

Bismuth. The epithelium shows a few degenerative changes. Many cells of the superficial layer are small, with correspondingly small nuclei. In the basal layer many cells show small distorted nuclei, with distinct vacuolation of the cytoplasm. But most of the epidermis is apparently normal, with large well-stained nuclei. There are, however, a fair number of places where very definite hyperplasia has taken place, to the extent of doubling the normal thickness of the skin. In these areas there is no sign of degeneration. The nuclei are large, stain well, and have distinct nucleoli and chromosomes. A few mitotic figures were seen. Although the cell outlines are generally clear, there are in places suggestions of syncytium formation. While no definite downgrowth of epithelial cells has occurred, there are suggestive appearances, in that the cytoplasm of the deepest cells often merges gradually into the connective tissue, there being no clear line of demarcation as in the normal skin. The connective tissue cells seem to be increased in number and have normal cytoplasm and processes.

Pigment is present in the superficial layer of cells and as spheroidal masses in the epithelium. Most of it is, however, present in chromocytes which show the same position and degenerative changes as in the "selenium" specimens in the present series (see above).

The dominant feature in the "copper" specimens is degeneration. The "selenium" specimens show somewhat less degeneration and some more obvious hyperplastic areas. The "gold" specimens show marked hypertrophy, syncytium formation and peripheral keratinization of the hyperplastic areas. The outstanding feature of the "lead" specimens is degeneration,

though small hyperplastic areas can be distinguished, while the early changes in the "bismuth" specimens are less marked than in the "lead," and after twenty days the specimens have regained a more or less normal appearance.

TABLE VII

SHOWING CHANGES IN EPITHELIUM AS A RESULT OF IRRADIATION IN 5 PER CENT COLLOSOL FOR ONE AND A HALF HOURS

Group III. Series D

Time after Exposure	Copper	Selenium	Gold	Lead	Bismuth
48 hours	.....	.....	Some degeneration, but in limbs and tail very marked hyperplasia with keratinization of periphery of hyperplastic areas.	General degeneration; but a few hyperplastic areas present.	General degeneration; but a few hyperplastic areas present.
8 days	Marked atrophy: distinction between layers of epithelial cells lost.? Some indistinct suggestions of occasional local hyperplasia.	Atrophy with small hyperplastic areas. Degeneration rather less marked than in copper specimen.	Some degenerative changes. In limbs and tail, hyperplasia, syncytium formation and peripheral keratinization of hyperplastic areas.		
20 days	Marked atrophy and degeneration.? Degenerated remains of old hyperplasia.	Atrophy and degeneration. Remains of small areas of hyperplasia.	Degeneration. But remains of hyperplasia and syncytium formation in basal layer.	Degeneration and atrophy. Remains of some hyperplastic areas.	Comparatively little change from normal. A certain amount of degeneration.

GROUP III. *Series E. Tadpoles irradiated as before (Series C and D), but in presence of 1 per cent collosol instead of 10 per cent (C) or 5 per cent (D).*

Only a few specimens were thus irradiated. The collosols used and the times after exposure at which they were examined are as follows:

TABLE VIII

Copper	Selenium	Gold	Bismuth
.....	.....	48 hours	48 hours
.....	.....	96 hours	96 hours
10 days	10 days	10 days	.....

SPECIMENS EXAMINED FORTY-EIGHT HOURS AFTER EXPOSURE

(*Gold and Bismuth*)

Gold. A moderate amount of cell shrinkage and vacuolation can be seen throughout the epithelium. There is occasional slight, though definite hyerplasia of the basal layer. There is very heavy pigmentation of the superficial cells, while a spheroidal chromocyte is seen here and there in the epithelium. Most of the pigment is present in deeply placed cells which show active arborization.

Bismuth. In the greater part of the skin the changes are but slight, and such alterations as there are seem to be in the direction of degeneration, as the cells of both layers are somewhat shrunken together with their nuclei. There is much pigment in the superficial layer, but most of it is present in the deeply seated, actively arborizing chromophores.

In the limbs, however, more marked changes, and these of a hyperplastic character, have occurred. The basal cells seem to show an early invasion of the corium, and there are present a few "pagetoid" cells closely resembling those seen in the silver (17 days) specimen of Series C. In one place there is a column of epithelial cells, of which the nuclei are separated, the whole presenting a picture very like that exhibited by osteoblasts. Superficial keratinization has occurred in places, and is accompanied by a deposition of a stratum of pigment. While there are present some

degenerating epithelial cells which contain sickle-like masses of pigment, there are many containing a pigment which has assumed a sickle-like or arrow-head formation.

SPECIMENS EXAMINED NINETY-SIX HOURS AFTER EXPOSURE

(Gold and Bismuth)

Gold. Here the general picture is one of degeneration. Both layers of the epidermis have small cells with shrunken irregularly stained nuclei and much vacuolation. There is a great deal of dust-like pigmentary deposit in the superficial layer, together with an occasional spheroidal clump, while the deep chromocytes exhibit fragmentation. The connective tissue of the corium seems to be edematous and shows as a faintly stained pink ribbon with here and there an occasional active-looking nucleus.

There are, however, numerous patches of hyperplasia, which in some instances have definitely invaded the corium. Here the nuclei are large and have clear nucleoli and chromosomes. But the cells in the middle of the hyperplastic area have either degenerate nuclei or no nuclei at all, and contain much pigment in the form of fine granules. The cell outlines are distinct, there being no obvious syncytium formation. But even in these hyperplastic areas there is evidence that degeneration is supervening in the active cells.

Bismuth. The cells of the superficial layer are mostly flattened, but their nuclei are large, intact and deeply stained and there is no sign of vacuolation. In some places the basal layer shows hyperplasia and there seems to be definite syncytium formation with early invasion of the corium. The epidermis contains much finely scattered pigment; but the majority of the chromocytes are intact, lie deeply and show active arborization. The connective tissue cells have all large, well-stained nuclei and seem to be increased in number.

SPECIMENS EXAMINED TEN DAYS AFTER EXPOSURE

(Copper, Selenium, Gold)

Copper. Extensive vacuolation of all the epidermal cells is the outstanding feature, the nuclei being small and distorted. There are a few areas which show traces of hyperplasia, but here also degeneration has definitely occurred and there is no sign of invasion of underlying tissues. The chromocytes are generally large, very flattened, lie deeply and show no arborization, while signs of fragmentation can be detected. The whole picture is one of degeneration, though this is nowhere so extreme as to hide the original structure of the skin.

Selenium. The whole of the superficial epithelial cells appear to be degenerating; but in the basal layer there are occasional hyperplastic areas where it has increased to four or five cells in depth. Although these cells have large, well-stained nuclei, neither mitotic figures nor invasion of the underlying structures can be seen. There is a moderate amount of pigment in the outer epithelial cells, but most of the pigment is present in the chromocytes which lie deeply. These, however, seem to be undergoing degeneration as they are unusually transparent and exhibit signs of commencing fragmentation.

Gold. Degenerative changes are again the outstanding feature. The greater part of the skin has retained its two layers, although here and there only one can be distinguished. The cells of the basal layer are mostly shrunken and in places show vacuolation; there are a few hyperplastic areas and in some places syncytium formation. There is no invasion of the corium; the chromocytes lie deeply, are flattened and abnormally transparent, show early signs of fragmentation and have no tendency to arborization.

Here again the outstanding features of the specimens irradiated in the presence of 5 per cent collosols is degeneration in the case of the "copper" and "selenium" specimens—especially the former. Specimens irradiated in the presence of "gold" show fairly well marked initial hyperplasia followed by degeneration. In the "bismuth" specimens the hyperplastic changes appear more persistent.

CONCLUSIONS

Irradiation of tadpoles in ordinary water for one and one-half hours results in

TABLE IX

SHOWING CHANGES IN EPITHELIUM AS A RESULT OF IRRADIATION IN 1 PER CENT COLLOSOL FOR ONE AND ONE-HALF HOURS

Group III. Series E

Time after Exposure	Copper	Selenium	Gold	Bismuth
48 hours			Moderate shrinking of epithelial cells, but some hyperplasia in basal layer.	Some hyperplastic changes noted in epithelium of limbs with early invasion of corium and superficial keratinization.
96 hours			General degeneration; but some areas of hyperplasia which have definitely invaded the corium.	Hyperplastic patches in the basal layer, with syncytium formation and invasion of the corium.
10 days	Marked degeneration; but there are traces of small hyperplastic areas which have degenerated.	Degeneration with occasional small hyperplastic areas.	General appearances of degeneration, but a few hyperplastic areas persist.	

temporary hyperplastic changes in the epithelium with a certain amount of syncytium formation. Increased nuclear activity can be seen in specimens examined immediately after exposure. The hyperplastic changes are best marked in specimens examined from forty-eight to eighty-four hours after irradiation. In seven days after exposure hyperplasia has been succeeded by atrophy.

Specimens irradiated for two hours show traces of commencing hyperplasia immediately after exposure; but in those irradiated for five hours, hyperplasia can be made out immediately after exposure although it is obviously undergoing degenerative changes. In the five-hour specimens it must also be noted that degeneration is practically complete in four days after exposure.

The addition of 0.04 per cent of protargol to the water in which the tadpoles were irradiated produced such a marked increase in the hyperplastic changes that we decided to continue the observations by substituting small quantities of other colloidal elements. These were selected according to their atomic weights and numbers. It was clear that the elements of lower atomic weight which we employed (Cu, Se) produced mainly degenerative changes, but in the case of silver the matter was different.

Indeed the most striking feature throughout the whole set of experiments was the high degree of hyperplastic change found in the epidermis as a sequel to irradiation in the presence of colloidal silver (10 per cent mixture in water of 1 in 2,000 "collosol" silver), and also the length of time which the hyperplastic condition persists.

The specimen of gold "collosol" (1 in 2,000) was found to be too toxic to allow of a 10 per cent mixture in water being used, but with a 5 per cent mixture marked hyperplastic changes resulted, especially on the tail and limbs. The peripheral cells of such a hypertrophic area exhibited some tendency to keratinization, while syncytium formation was evident in the deeper parts. The specimens came next to the silver series as affording evidence of hyperplasia.

In whatever concentration it was used (10, 5 or 1 per cent mixture of the 1 in 2,000 collosol in water) copper produced markedly early and destructive effects. Sometimes suggestions of sporadic patches of hyperplasia were present but even here degeneration supervened.

With selenium the changes were similar but less marked and hyperplastic areas could be definitely made out. Here again degeneration soon made its appearance.

Considering the elements of higher atomic weight—lead and bismuth—lead appeared to produce mainly degeneration with but few suggestions of hyperplasia whether used in 10 or 5 per cent mixture. With bismuth the changes were less marked but such hyperplastic areas as were present were more marked than in the case of lead. With a 1 per cent bismuth mixture the hyperplasia was much more definite.

In view of the very marked effects produced by silver and to a less degree by gold it would seem probable that some particular range of wave lengths is responsible for the marked hypertrophic changes.

Of course in all cases the tadpoles were exposed to the direct primary beam of rays from the Coolidge tube, the effect of which, as has already been seen, is to produce a temporary hyperplasia, and so this must be taken into account. For instance, in the copper series the small and indefinite hyperplastic areas may be due to the action of the primary beam; the main feature of specimens irradiated in the presence of copper is, however, marked and early degeneration. Selenium holds an intermediate position between copper and silver; while with lead and bismuth, although degeneration is prominent, hyperplasia also occurs.

THE PHYSICAL CHARACTERISTICS OF SOURCES OF ULTRAVIOLET LIGHT FOR HELIOTHERAPY

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THE development of heliotherapy, particularly in the field of ultraviolet radiation has made such strides in the last few years that purely empirical formulae are no longer adequate. Especially is this true when it is desired to translate the procedure and results of one worker with a particular source into corresponding values for a different source of radiation. The term "ultraviolet light" without specification of its character is no longer sufficient. To hope to clarify the present knowledge of the radiations thus spoken of by a mere catalogue of sources and their features would be vain. The catalogue would be quite gratuitous at present and were it not, it could hardly hope long to maintain its utility as a complete codex of facts. It is therefore the purpose of the present paper briefly to describe the essential features of only a few of the typical modern sources of ultraviolet light, with particular reference to this part of their radiation, and more particularly to set forth the physical laws according to which such sources function and following which they may be developed and their radiations may be prescribed and administered. At the same time the author hopes to avoid as far as possible entanglement in discussions of the physiological reactions to these radiations, for regarding such matters there is not always agreement, and even when they have been removed from the realm of speculation or opinion they are entirely without the province of the physical laboratory and only encumber the description of the radiation with too early questions of its proper utility.

In a list of sources of ultraviolet light useful to man the sun itself ought to stand first, *honoris causa*. It needs but brief description in the present exposition. It is now commonly known that the sun's light as we receive it is usually a very meager source of ultraviolet radiation. (Having in mind the vital difference between sunlight unfiltered save by the clear summer atmosphere and that which passes through commercial windowglass, the writer, when using the term ultraviolet light refers to wave lengths shorter than about 3600

Angstroms.) The sunlight that gets through our atmosphere has at best a short wave length limit at about 2850 A; and generally further attenuation by the atmosphere makes this lower limit range as high as 3200 A even in fairly clear weather. Energy "spectra," or curves showing the wave length distribution of energy from two specimens of sunlight are shown in Figure 1.

The character of the sun's spectrum is for the present purposes not much different from that of an incandescent black body, to which an arc crater is a close approximation. (By a black body is meant one that neither transmits nor reflects any radiation falling on it.) The solar spectrum is, of course, crossed with myriads of fine absorption lines of solar origin, named after Fraunhofer, but for physiological purposes such a finely resolved spectrum is not demanded and it may be treated as though continuous. Its further—and important—deviation from the spectrum of a black body at a like temperature is primarily due to the opacity of our atmosphere to shorter wave lengths. This loss of light in the atmosphere arises from three causes; true absorption, scattering, and reflection. True absorption, as by water vapor or ozone, occurs in discrete wave lengths or bands of wave lengths and results finally in the re-emission by the absorber of longer wave lengths of radiation such as heat in all directions, including toward the earth. Such absorption by ozone causes the almost complete opacity of the atmosphere at 2850 A. Scattering is caused by minute particles such as mist, smoke, and dust, comparable in size to the wave length of the light. This phenomenon occurs for all wave lengths but its magnitude is inversely proportional to the fourth power of the wave length and so the scattered light of the clear sky is blue and the residual transmitted light of the setting sun is reddish. Reflection is a term which should be reserved for the turning of light by particles large compared to the wave length of the light. Such particles, excepting dense aqueous clouds, occur only in special cases in the air when borne on winds, for they otherwise settle quite rapidly. The whiteness of clouds arises from this cause as does also that of snow. All these causes conspire, especially in cities and when the sun is low, to diminish

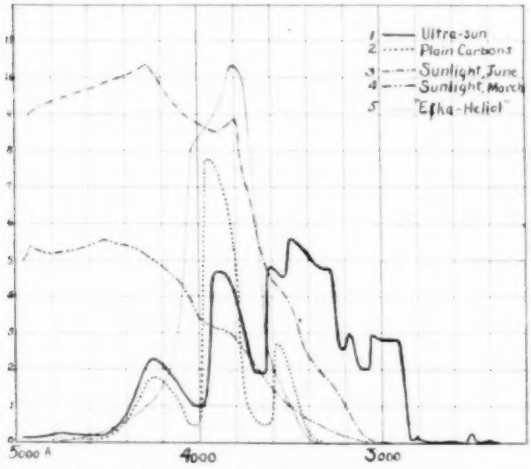

FIG. 1. Spectral distribution of energy in several sources. 1. Ultra-sun carbons in open arc. 2. Ordinary carbons in open arc. 3. Sunlight in June. 4. Sunlight in March. 5. Efka-heliol (enclosed) arc.

Curves 1 and 2 are for light from the arc proper; Curve 5 for total light including crater radiation. Curves 3, 4, and 5 are transcribed from Kohl and Burbach;[1] Curves 1 and 2 were obtained by the author photographically.

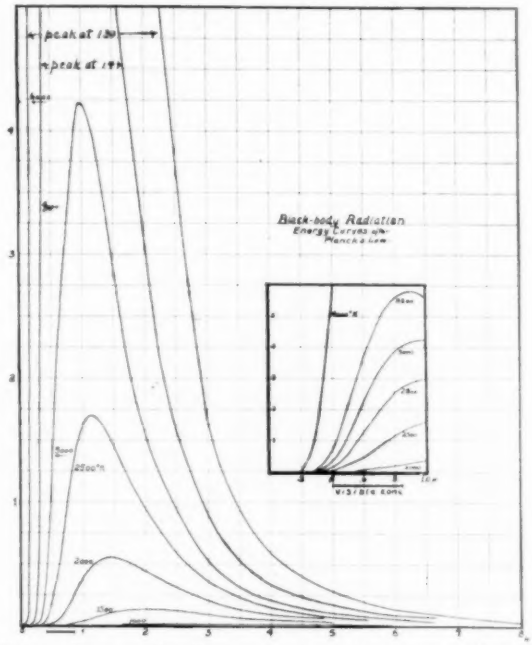

FIG. 2. Energy distribution in the radiation of a "black body."

our sunlight, and of them the first two particularly screen off the shorter rays. A spectrum of New York sunlight of early April is shown for comparison with laboratory sources in Figure 3.

Among the laboratory substitutes for sunlight a peculiar place has been held by the mercury vapor lamp in quartz. This lamp, which is so widely known for the abiotic power of its intense radiation of the shortest wave lengths transmissible through air and quartz, has been the subject of

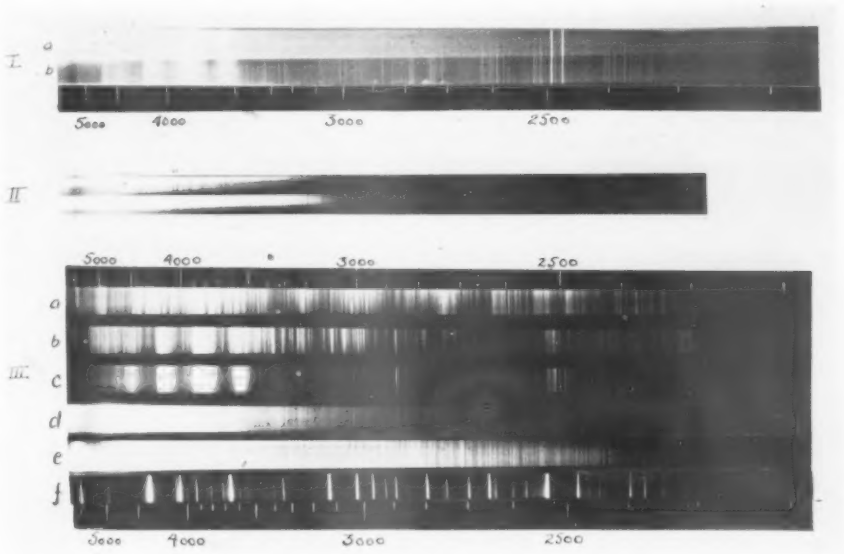

FIG. 3.

I. Two exposures (equal) to open arc of 75 amperes. (*a*) crater light; (*b*) flame light.

II. Two exposures to sunlight, early April, New York City. (The two strongest absorption lines are H and K of calcium.)

III. Flames of several open arcs, and a mercury lamp: (*a*) iron; (*b*) ultrasun carbons; (*c*) ordinary carbons; (*d*) cored (white), carbons; (*e*) tungsten; (*f*) mercury lamp in quartz.

extended report, both of its physical characteristics and the physiological reactions to its radiation. But in order to place it properly among the other sources a brief resumé will be given.

The spectrum of the mercury lamp is not continuous. It does not in any respect resemble sunlight. The spectrum through the ordinary photographic range is shown in Figure 3. Beyond the limit of sensitivity of the photographic emulsion (on account of the opacity of the gelatin) the mercury lamp has one of the very strongest lines of its spectrum at about 1850 A, barely within the limit of transparency of air and of good fused quartz. Of the total radiation from this lamp in normal operation some 15 to 20 per cent lies beneath 3000 A wave length, that is, shorter than any sunlight we get in low altitudes. To give a more accurate estimate of this very short wave length radiation is impossible, chiefly because of the opacity that the burner acquires with use.[2] This opacity, which increases at a rate depending on the burner temperature and the power used, is greatest for the shortest wave lengths, and may for these not infrequently be as high as 50 per cent. The photographed spectrum in Figure 3 was made from the radiation of a used but by no means exhausted burner. (It should be remarked that this opacity, which has its causes in contamination of the interior quartz surfaces by metal from the electrodes and in a slow transformation of the heated quartz, is entirely apart from that arising from external soil of the burner by organic material from the skin, which in the heat of the burner becomes opaque to short wave lengths.)

An important condition necessary to the reliable stipulation of the characteristics of a mercury lamp is that it shall have been lit long enough to have reached a steady

state—Pohle, after a careful study, says nearly thirty minutes.[3] The radiation from the lamp before it has reached temperature stability is chiefly weaker than its steady value; the differences in the distribution of energy are not significant save in a few lines. The absorption frequently mentioned as weakening the radiation from the hot central core is a particularly restricted phenomenon. The cooler outer vapors do absorb the center of several lines, but the total radiation of these lines has been scattered over a range of wave lengths by electrical and thermal agitation of the emitting atoms in the very hot central zone of the arc, and these "off-center" radiations cannot be sensibly absorbed by the cooler surrounding vapors. The vital rôle played by this absorption when the light is used as a stimulus in certain spectrum researches is due to the same causes that confine it to the center of the emitted line, and is practically nil in heliotherapy, for while in the former uses excitation occurs very selectively at the natural frequency of the atoms, i. e., the wave length of the undisturbed line, in therapy no critical frequencies will coincide with the lines of the mercury spectrum. The question reduces simply to what fraction of the total energy was removed by the absorption.

The variation of the radiant efficiency of the mercury lamp with different operating currents has been studied, with the conclusion that for small variations about the normal operating current the ultraviolet intensity is about proportional to the square of the electrical power; but this increase of efficiency with power does not continue far until a maximum is found above which the radiations are more generously located in the infra-red wave lengths.

A quite different type of source of ultraviolet light as a substitute for the sun is the open arc between carbon or metallic poles. This source has been developed in two distinctly different modes and because of the fundamental differences in their radiations and their laws of behavior they must be treated separately. The older type, used by Finsen and his followers, is simply a high current arc between plain carbons. No particular attention was paid to the spectrum of the vapors in the arc for it was known that some 80 per cent of the visible radiation of the arc came from the hot crater of the positive carbon. (For this reason direct current was much preferable to alternating.) This somewhat sunlike crater radiation has a small ultraviolet component and when this is wanted in sufficient amounts to make its use feasible in heliotherapy a low current arc is found to be too feeble, so a larger arc is obtained with currents of 60 to 100 amperes or more.

The type of radiation emitted by this incandescent carbon is very like that from an ideal black body, of which the characteristics are accurately known. The clearest survey of this type of radiation may be had from a group of curves of energy distribution according to Planck's law, drawn for several relevant temperatures. These constitute Figure 2, the detail of short wave lengths being an inset. The lowest temperature shown, 1000°, is visually red; the curve at 3000° is a bit below the melting point of tungsten. Of the curves at 4000 and 6000° only the lower parts can be shown—their peaks would rise to about 14 and 130 units respectively on the ordinates used. These temperatures are nearly the values for the crater of the carbon arc and the sun. In relation to these curves the following laws hold an important place. They may be deduced from Planck's law but are actually of earlier origin. Stefan-Boltzmann law: The total radiation of a black body is proportional to the fourth power of its Kelvin temperature. (Kelvin scale is closely 273° plus centigrade temperature.) Wien's maximum law: The product of the wave length of maximum radiation of a black body and its temperature is a constant.* These laws which describe "black-body" radiation are, for the present purposes, statements of upper limits, for no ordinary substance is perfectly black. To account for the difference between the radiation of an ordinary body and one which is perfectly black we are beholden to Kirchoff's law, which states that the ratio of the emission to the

*This constant has a value of 2885 micron-degrees. Thus one finds the maximum radiation of a tungsten lamp at about 1 micron (1 micron = 10,000 Å), an arc crater about 7000 Å, and the sun less than 6000 Å.

absorption is constant for all bodies, and equal to the emission of a black body. For any body less than totally absorbing the emission is thus inferior to that of a perfectly black body. This defection is, as a matter of fact, not great in the case of carbon so that when at 2056° K it radiates like a black body at 2000° (for 6560 A radiation). Other substances are much less nearly black. An inspection of the curves of Figure 2 will show that the ultraviolet light radiated by an incandescent solid such as the crater of an arc is a very small fraction of the total radiated energy. At 3000° it is quite negligible, at 4000° it is still absurdly small. The attainment of a greater relative amount of short wave length radiation from such a source as the crater of an arc or any incandescent solid thus evidently demands the attainment of a very high temperature—comparable to that of our sun. But to this end arcs may be operated on very heavy currents instead of the usual 6 to 10 amperes quite without success, for by this means the temperature of the crater is not appreciably raised. It is obvious that the larger arc obtained with such currents will in total radiate more heat and more light, but it is only a larger source and those 80 per cent of its radiations that come from the crater of the hot carbon are relatively distributed through the spectrum quite like those from a smaller arc crater—from a body at about 4000° K.

Lummer[4] has shown that the temperature of an arc crater, measured, for instance, by the wave length of its maximum radiation, may be greatly raised by operation of the arc under a gaseous pressure of several atmospheres and he reports having thus attained temperatures surpassing that of the sun. But this required a pressure of over 20 atmospheres and such devices are not easily available and would be in any case somewhat complicated.

In the total radiation of any arc between ordinary carbons the crater light has superposed on it a variable amount of light from the flame of the arc. This light is predominantly located in three bands falling between 4500 and 3500 A, and gives the flame its characteristic blue color. From this source, i. e., the arc proper, there is no contribution of significance below 3500 A save a slight appearance of a group of strong silicon lines near 2520 A. Spectra of an open arc of 7.5 amperes between $\frac{5}{16}$ inch metal coated carbons are shown in Figure 3. The continuous spectrum was taken nearly end-on to the positive crater, the other sidewise with the light of the flame only, both spectra having the same exposure. (In judging the significance of spectrum photographs it must be borne in mind that longer exposure would bring out evidence of fainter radiations without increasing in the same ratio the image of the stronger, due to the fact that this light had already converted all the silver halide on which it fell.)

The attempt to produce hotter or more efficient sources has also led to the use of enclosed arcs. A comparison of this source to an open arc includes two factors, the crater and flame light. The light from the crater is not sensibly altered in energy distribution because the temperature of the crater is not raised by an enclosure that does not materially raise the pressure of the arc vapor. The light from the arc proper is considerably enhanced, but only by a uniform increase through the whole spectrum with no sensible addition of new wave lengths. If plain carbons are used this light consists of the bands previously noted in an open carbon arc, and the deficiency of shorter wave lengths persists. Evidence on this point is presented by Vahle[5] in two energy distribution curves for an open and a closed arc respectively. For the latter there is shown a nearly uniform intensification, about seven-fold, of the three bands mentioned, but no other feature appears.* An energy curve of the total light of an enclosed arc occurs in Figure 1.

In such an arc certain minor technical advantages arise due to the restriction of ventilation, such as steadiness of burning and decrease of carbon oxidation, which make the use of augmented power not so clumsy as in an open arc. How well these

* It should be observed that spectral distribution curves of the energy of a source, taken, as they must be, of light which has passed through a spectrograph slit, record the intrinsic brilliance of that narrow zone of the source whose image falls on the slit opening. The total illumination from a source, of one wave length or of all depends on the size of the source in a way not accounted for by the spectra. Particular ordinate values of different curves for various sources are thus not at once comparable to each other. The determination of such relative value waits on other measures such as monochromatic photometry of the whole source.

repay the trouble of maintaining the arc envelope in order is a matter of personal equation.

It must appear that the above described modes of development of the arc are somewhat cumbrous and inefficient, though not entirely futile means of obtaining adequate laboratory or clinical sources of ultraviolet light. The value that may be attributed to their longer wave lengths is conceded, but is apart from the present considerations.

An entirely different and much more fruitful departure in the development of ultraviolet arcs is the use of poles whose spectra have significant radiations in those ultraviolet zones of particular interest. Thus enhanced radiation of prescribed wave lengths, within certain limits, may be obtained without the use of more than nominal power, which is a fair advantage in the ease and comfort of operating the lights. There is the further point of versatility, for, when required, the lamp may be used with one or other poles for different purposes. The attainment of adequate radiations in a given spectral zone waits only on finding practicable chemicals to use for impregnating carbons or for replacing them. In Figure 3 several typical spectra of such sources may be at once compared. Energy distribution curves of the light from the center of open arcs between ordinary and "ultrasun" carbons occur in Figure 1. The "efficiency" of any of these sources would have to be defined anew for each therapeutic use and is thus not to be set down. It is, however, only necessary to observe the relative distribution of energy in a given spectrum to judge its utility.

In the lowest group of spectra of Figure 3 certain features deserve note. The iron arc is a very strong ultraviolet source but it is not easy to handle, being unstable and giving off some fumes of oxide. Ultrasun carbons are specially cored to have radiation in the zone 2900 to 3600 Å; their spectrum is notably weak in the visible range, so the arc is not uncomfortable to look at. Number 4 is special carbons which have very strong visible light of white appearance but weaken very rapidly below 3500 Å. The tungsten spectrum is one of very strong radiation throughout the whole region photographed, even surpassing the iron, which it also surpasses in obnoxious fumes.

These arcs burning between special poles at moderate currents, 6 to 7 amperes, include some continuous radiation from the hot positive pole, but it is of no ultraviolet strength. The spectra shown were made of the flame of the arc alone save in the one case mentioned. While it is not intended that these special arcs shall carry large currents the poles will in general stand considerably increased load, giving larger, more powerful illuminants; but this will not change the character of the radiation nor add anything to its spectrum except increased brilliance in all wave lengths. Such a practice would perhaps seem forced in view of the fact that the enhancement of the desired radiations has been the purpose of the special carbons or other poles. In many regards these special arcs thus briefly described deserve the most particular attention on account of their spectral characteristics, versatility, and general convenience of use.

A brief paragraph must be allowed in the matter of incandescent filament lamps. The substance of the paragraph shall be to dismiss these sources from the category of ultraviolet radiators. The reasons for this are simple. The highest temperatures to be hoped for cannot exceed the melting point of tungsten, and practically 3000° K is about the limit. Conceding to the filament the properties of total blackness, its ultraviolet radiation would be the mere fragment shown by the 3000° curve in Figure 2. The practice of running these lamps at overvoltage is of trivial benefit. The highest temperatures allowed by a leading manufacturer in any form of moderate powered lamp are barely over 3200° K.[7] To see what may thus be gained one may find in the inset of Figure 2 the curves for 2800°, 3000°, and 3200° K. When it is recalled that the emissivity of hot tungsten is but 50 per cent in the shorter wave lengths—and down to 20 per cent for longer—it should be clear that these filaments cannot be discussed as sources of ultraviolet radiation for therapy. These considerations apply without modi-

fication to those newer forms of lamps in which a tungsten bead, heated to incandescence by electrical bombardment, is the source of light. It is not necessary to remind the reader that these lamps are commercially available only in glass bulbs.

Underlying all the uses of the radiant energy of the sources described in the foregoing paragraphs there are certain physical or geometrical relations which must be observed in practice. Of these the most important may be the rule regarding illumination. Since light travels in straight lines through free or homogeneous space all the radiation sent out in a given cone remains in that cone until it strikes some obstacle and the consequence is the inverse square law of illumination. But from the nature of its origin the law implies a point source of light and for any other source it will not be true. In the use of a source of considerable size or housed in a reflecting hood the law may be far from true; in fact a parabolic reflector may give practically constant illumination within the reflected beam over wide ranges of distance. The illumination by a housed mercury lamp at various distances has been measured by Pohle,[3] that of some other lamps by Kohl and Burbach.[1]

Another physical law is frequently employed to prescribe dosage, according to which the product of the intensity of illumination times the duration of exposure is taken to be of constant value. It is true that the energy used is given by this product, but nothing further may be implied from that fact. Indeed a strict accountability to that fact itself will require that the surface illuminated under no circumstances change its receptivity for the energy. It is an entirely physiological matter to ascertain how the light of various intensities affects a given organism and how the effect depends on the duration of the exposure.

Another feature of valuable use should be the formation of a real image of a source projected on a restricted area. In this practice it may be shown that the intensity of illumination in a real image of a given source will depend on the square of the focal aperture of the lens employed (its diameter divided by its focal length), but will not depend on the magnification of the image. The argument of this proposition follows directly from the fact that all the light that was sent out in the cone which passed through the lens was directed to the image according to the simple distance formula $1/f = 1/p + 1/q$. Lenses for this purpose will need to be of quartz crystal at present, and one or two may be used. When large focal aperture is wanted a pair of plano-convex lenses may be preferred to the equivalent double convex on account of diminished spherical aberration—and cost—and they are mounted together as in a lantern with the plane faces out. The chromatic aberration of quartz is considerable but can hardly cause trouble in this use where highest precision of image formation is not demanded. The data for the refractive index of quartz show that a lens of 10 cm. for wave length Na 5893 A would have its focal length for Al 3966, 9.75 cm.; for Cd 2573, 9.13 cm.; for Cd 2144, 8.63 cm. A longer lens would be in the same proportion. Something in this direction is served by applicators which may be fitted to one of the small mercury lamps. While these form in general no useful real image they concentrate the light by refraction and internal reflection in useful directions. As an alternative to the use of lenses concave mirrors may be employed. The greater feasible aperture of these is offset by their imperfect reflecting power. Data on this matter are of interest both for the point in hand and because of the general use of hoods over arcs. The commonly seen nickel surfaces, when clean, reflect nearly 50 per cent of the involved light shorter than 3000 A. Aluminum surfaces, which are really oxide, are not quite so good. Silicon, the best known ultraviolet mirror for the ordinary range in air, surpasses 70 per cent between 2000 and 3000 A, but is not yet in practical use, being available only in brittle cast slabs. Other good mirrors of alloys such as "magnalium" and certain of the "speculum metals" are not generally available. For all practical uses nickel seems to be preferable on account of its ease of fabrication and maintenance of surface.

The practicability of a source is hardly a

secondary feature to its having a suitable spectrum. This is a point of which but brief comment is proper here—it involves numerous matters of clinical procedure. For the last mentioned purpose of local use of real images the high intrinsic brilliance of arcs in air should make them valuable beyond a more extensive burner. The initial distribution of radiation about the source is quite varied in different arcs, and is not always advantageous. In a straight arc, erect with the positive pole above the crater radiation comes off predominantly downward, the light from the flame predominantly in the horizontal plane. If the carbons are set at an angle of about 90° to each other the radiation is considerably more intense in front of the arc both for the crater light and for the flame, but more for the former. This being predominantly visual or longer, such inspection may be misleading regarding the ultraviolet from the flame.

With a precise knowledge of what radiations a lamp emits and how they may be administered there naturally arises the question of the possibility of their measurement by a nonphysiological reaction. That such a measurement should have physiological significance and be of easy accomplishment is a rather exacting condition to impose. A survey of the available reactions to ultraviolet light discloses three possibly useful types; photochemical reactions, photoelectric currents or voltages, and the optical sensitivity of selenium. Of the first of these a particular example in the liberation of iodine has been carefully studied by Pohle.[3] It lacks nothing essential for precision and is fairly simple, but what is outstanding is that the reaction goes on differently in different wave lengths of light and therefore may not take rational, or at any rate useful, account for physiological purposes of the variation of energy distribution in varying sources. It can obviously not be at once transferred to use with other lights on the basis of Pohle's data with mercury.

Photoelectric currents offer perhaps a simpler means of illumination measurement. Here again proper regard must be had for the wave length sensitivity of the cell. Dorno[5] describes the advantages of a cadmium cell in uviol glass, which cell somewhat simulates the erythema sensitivity of the skin to various wave lengths. The same metal in quartz, as suggested by Szilard,[6] he counts less useful because of its too great sensitivity to the short wave lengths screened off by the uviol glass.

The use of a selenium cell, whose resistance falls tremendously on illumination, is hardly a fortunate proposal in ultraviolet photometry, although an instrument is abroad for clinical uses. The chief fault with this cell is its great sensitivity to visual light. Its reaction to a mercury lamp is but a few per cent of that to a modest white arc.

In conclusion, the sources of ultraviolet radiation for therapy may be thought of as the mercury lamp, with its very intense short wave length radiation and little else; the heavy current arcs, which with great energy outlay furnish a modicum of ultraviolet light along with much radiation of visual and longer wave lengths; and arcs with special poles, which furnish a moderately intense controllable ultraviolet spectrum with a tolerable amount of other radiations. Incandescent filaments are not of moment. The physical laws are described according to which these sources function, so to enable one to judge how much or little the characteristics of the sources may vary with their mode of operation, and something of what may be accomplished by modification of working conditions of the lamps. The optical laws which define the illumination of objects by these sources are pointed out and the limits of their application are indicated. Certain points are noted at which a bridge from radiant energy to biological or physiological reaction must be constructed of firm facts of laboratory and clinical observation. It is hoped that the foregoing paragraphs may help in some little way to establish a pier at one end on which such a bridge may be securely supported.

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(The work of Dorno, Hausser, Vahle, and others in the realm of the physical bases of heliotherapy is assembled *in extenso* and with extended theoretical discussions of certain points in that section of Meyer's Lehrbuch, edited by Hans Meyer, published by Urban and Schwartzenberg, 1925.)

A CLINICAL AND ROENTGENOLOGIC STUDY OF HIGH COLONIC IRRIGATIONS AS USED IN THE THERAPY OF SUBACUTE AND CHRONIC ARTHRITIS*†

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SECTION A—CLINICAL—R. G. SNYDER, M.D.

ARTHRITIS is a common disease. It is usually slowly progressive and of long duration. It is a disease commonly considered to have a bad prognosis in the majority of cases even under the best of treatment. It often ultimately cripples the patient and incapacitates him for earning his livelihood. Since arthritis, however, is not a fatal disease, it has failed to arouse among the medical profession, as a whole, the interest which it deserves.

The writer has for the past twelve years been particularly interested in the study and treatment of arthritis. Up to four years ago, he employed all the then well-known and commonly accepted forms of therapy; that is to say, massage, passive and active motion of the joints, baking, hydrotherapy, diathermy, exposure to sunlight and to the ultraviolet rays of the quartz lamp. In addition, the systemic measures employed were improvement of the patient's hygiene, restriction of the carbohydrate intake, and increase in the total vitamine content of the food. The usual armamentarium of such drugs as salicylates, aspirin, tolysin, atophan, and colchicine were freely used. Vaccines as well as nonspecific foreign protein therapy were also frequently employed. The thorough and intensive application of these measures in conjunction with the liberal use of mental encouragement to the patient resulted in a very satisfactory clinical progress in a fairly large group of cases. In a second group of cases, treated in a similar manner, only a moderate degree of clinical improvement could be obtained. Finally, a third group of cases, always encountered, failed to respond to any and all of the above mentioned forms of treatment. The patients of this group became, as a rule, progressively worse, in spite of all therapeutic efforts to check the progress of disease. The cause for the failure to obtain clinical improvement in this group of cases has always been puzzling. At first, the author believed that an improper or incomplete eradication of foci of infection in the head was responsible for the therapeutic failures, but during the past four years a more extensive experience in treating these refractory cases has made it apparent that in all probability, the bad therapeutic results were due to undiscovered foci of infection or toxin absorption from the genitourinary and gastrointestinal tracts.

It is well to emphasize at this point the fact that in arthritis not one, but many etiologic factors are usually responsible for the production of the disease. In some

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† This study is based on cases seen in private practice and in the Department of Arthritis of the Hospital for the Ruptured and Crippled, New York City.

cases, infection plays the chief rôle. In other cases, metabolic disturbances or degenerative changes or absorption of toxins are of greater etiologic importance, but in many instances a combination of all of these factors seems to be responsible for the onset of the disease. Clinically, it is usually impossible to determine accurately in every given case the relative importance of each of these factors. Therefore, the efforts of the physician must be directed to the elimination of every cause which may be of possible etiologic importance in the individual case under treatment.

Up to the present, a great deal of attention has been given to infection in the teeth, tonsils, and accessory sinuses of the head, but much less attention has been directed to infection in other parts of the body, as a factor in the etiology of arthritis.

The gastrointestinal tract particularly has not received adequate attention. It cannot be denied that under unfavorable circumstances it may serve as a focus of infection or source of autointoxication. Lane[1] deserves great credit for emphasizing the importance of stasis in the colon in many systemic diseases. Persson,[2] Rea Smith,[3] Carter,[4] and Forbes[5] have called attention to the importance of considering stasis and infection in the colon as a possible etiologic factor in the production of chronic arthritis.

Experimental proof of such a direct relationship has not as yet been definitely demonstrated nor accepted by the medical profession as a whole. However, in spite of the lack of general acceptance of this hypothesis, the author has, empirically, during the past four years, whenever clinically indicated, added to this older form of therapy of subacute and chronic arthritis a system of treatment which aims at the elimination and correction of intestinal stasis. Since the addition of this form of treatment his clinical results have shown a definite improvement.

At this point the writer wishes to emphasize that he does not by any means regard the colon as an etiologic factor in all cases of subacute and chronic arthritis. No doubt, in many cases the colon bears no relationship to the onset of the disease, but it should be remembered that when indicated the elimination of colonic stasis has been of definite value in the management of the disease.

There are a number of different methods in general use for the correction of intestinal stasis.

(1) Intestinal rest, obtained by complete or partial starvation over varying periods of time for the purpose of obtaining improved tone of the intestinal musculature is one method at times employed. This usually necessitates either complete rest in bed or a curtailment of the patient's working capacity. In debilitated subjects it is very often inadvisable to use this form of treatment, because it may still further lower their resistance.

(2) The use of a diet containing much roughage is excellent for those who are able to take plenty of exercise, but most patients suffering from arthritis are obviously unable to exercise. A diet rich in roughage has generally the added drawback of being rich in carbohydrates. These have been shown by Pemberton[6] and others to be contraindicated in arthritis.

(3) The continued use of cathartics does not seem to be of great value. Most patients suffering from arthritis usually give a history of having taken various mild cathartics for months or years without permanent relief. In the author's experience the use of drastic cathartics over a prolonged period of time has been noted to result in a marked irritation of the intestine, and usually in a general weakening of the patient, without any marked improvement of the arthritis.

(4) Attempts at flushing the colon by imbibition of large amounts of fluids are usually of limited value, because of the rapid absorption of water during its passage through the stomach and small intestine. Practically the same objection holds good for the use of duodenal or jejunal tubes. In addition, the patient frequently experiences considerable difficulty in swallowing and retaining the tube. Furthermore, the tube often becomes knotted and coiled in the stomach, and it may take an hour or more for its passage into the

duodenum. In office practice the difficulties and unpleasant features of the procedure mitigate against its general use.

(5) Flushing the bowel through an appendicostomy is undoubtedly a valuable method. However, the inconvenience and dangers of the necessary operative procedures make it inadvisable to employ this method of irrigating the colon, unless all other methods have failed.

(6) Enemas have been used since time immemorial. Often, no doubt, the bowel can be cleansed thoroughly by an irritant enema properly given, but in many cases irritant enemas become ineffective after repeated application. In other cases, they are ineffective from the beginning. Another factor of possible importance is that enemas are usually taken by the patient at his home, where the position, the regularity of administration, quantity of water, type of chemical irritant and the length of time of retention in the bowel are left to the whim of the patient and cannot be controlled by the physician. The writer has failed to observe any satisfactory clinical improvement in cases of arthritis in which bowel stasis was combatted by the use of enemas given at home. On the other hand, he has seen a fair proportion of cases in which the administration of enemas was eventually associated with the onset of pruritus, hemorrhoids, or prolapse of the rectum.

(7) Finally, there are the so-called "low" and "high" irrigations. The terminology commonly used in referring to various types of colonic irrigations is very confusing. To some, a "low" irrigation means the insertion of a 3 or 4 inch rectal tube and a flushing of the bowel and possibly of the sigmoid. The term "high" colonic irrigation implies to many physicians the flushing of the colon through a tube inserted for 8 to 15 inches, and a belief that the solution will reach farther into the colon because of this longer tube. It is surprising to learn how widespread the misconception is that a long tube is necessary for getting irrigating solution into the cecum.

It seems to the writers that the term "high" colonic irrigation as commonly employed at present is a misnomer. From repeated roentgenologic observations it is clear that the word "high" cannot apply to the distance in the colon reached by the irrigating solution, because fluids introduced either through a rectal tube or a 15 inch tube can be made to reach the cecum equally well. The term "high" then should be used in reference to the distance from the anal canal which a tube can be made to reach proximally into the colon. Bearing this distinction in mind it is not correct to refer to a 15 inch distance into the colon as "high" when repeated roentgenologic observations have proven to us that often a tube inserted for 36 inches into the colon reaches only slightly beyond the sigmoid. For these reasons the writers have arbitrarily adopted for the purposes of this paper the following nomenclature:

(1) Low irrigation—to signify the insertion of a rectal tube for a distance of 3 to 4 inches.

(2) Medium irrigation—to imply the passage of a 36 inch tube, which in many instances reaches into or just beyond the sigmoid.

(3) High irrigation—to mean the insertion of a 54 inch or longer tube and its passage into the colon as far as the splenic flexure or into more proximal portions of it, as far as the cecum.

Dr. George R. Lockwood of New York City was among the first, if not the first, in this country to employ a long rubber tube of large caliber for colonic irrigations. In 1899 he made his first attempt to irrigate the colon with the aid of a long stomach tube introduced through the rectum. In 1903, he began using a tube of larger caliber. To avoid the coiling of the tube and the danger of traumatizing or perforating the bowel wall with the fairly sharp edges of the open end of the stomach tube, he finally adopted in 1906 tubes of larger caliber, 24 to 36 inches in length, with a rounded closed end. One-half inch and an inch and a half respectively below the tip of the tube, there were elongated, relatively large bevel-edged openings placed on opposite sides of the tube. This type of tube is now commonly known as the Lockwood colon tube. In a personal communication he states that as early as 1911 he convinced himself by roentgenoscopic examinations that this

tube could consistently be made to pass into the sigmoid, and often beyond it. These irrigations were always given by nurses well trained in the technique of this type of irrigation, who were working under his direct supervision.

Some years ago the writer began applying this type of irrigation in those cases of arthritis in which intestinal stasis was thought to be a factor. Because of uncontrollable circumstances the irrigations had to be given in a very unsystematic manner at intermittent intervals by hospital orderlies, inexperienced undergraduate nurses, or nurses who had had but little experience with this type of irrigation. After a year's trial under these circumstances the conclusion was reached that the clinical results in the cases of arthritis treated did not justify the additional labor and expense involved in the procedure.

Since Lockwood had obtained such excellent clinical results through his systematic use of colonic irrigations in many conditions associated with intestinal stasis, it was felt that the author's unsatisfactory clinical results were possibly due to the haphazard manner in which the irrigations, through force of circumstances, were given in the hospital wards. He believed that his unfavorable impression regarding the value of colonic irrigations in subacute and chronic arthritis with intestinal stasis was perhaps not justified unless the method could be tested under better conditions and improved technique.

It was at about this time that the writer learned of colonic irrigations given by O. B. Schellberg, a technician, who through long experience had become expert in inserting the long tube into the colon. The writer felt that perhaps the length of tubing inserted into the colon was an important factor and determined to give this method a trial.

The first 12 cases of subacute and chronic arthritis with colonic stasis referred to Mr. Schellberg for colonic irrigations showed on the whole a very definite clinical improvement. Since then, 157 patients for whom colonic irrigations were indicated have been treated under the writer's direct supervision by a trained staff of technicians, using in general the same technique, but with such modifications as seemed indicated in the individual patient under treatment.

It cannot be said that the high irrigations exclusively were given to any of this group of patients. At the beginning of treatment a short and small caliber tube is used. As the patient becomes accustomed to the procedure, larger and longer tubes are employed, until finally every irrigation is given through a 54 inch colonic tube. The mere employment of a long tube does not warrant the assertion that a high irrigation was given. The tube may coil in the bowel due to the great redundancy of the sigmoid and may reach only slightly beyond it. A roentgenographic or roentgenoscopic examination of the position of the tube in the abdomen is the only definite evidence of the exact position of the tube within the colon. So far it has not been possible, for practical reasons, to check the routine irrigations in this manner. The writer does not feel justified therefore in concluding at this time that the benefit derived from the irrigations is due wholly to the use of the long tube. A number of other factors which enter into any system of irrigations must be carefully weighed and properly evaluated. Instead of a few irrigations given at irregular intervals by inexperienced individuals, the author now insists before beginning treatment that the patient submit himself to a minimum course of twenty to thirty irrigations given in a routine manner by experienced technicians. After an interval of time varying from a few weeks to a few months the series of irrigations is repeated if the clinical progress of the case is not satisfactory or if a recurrence of symptoms occurs. At the beginning of treatment a daily irrigation is given for a week or ten days. The interval between irrigations is then gradually lengthened until the patient gets an irrigation but once a week or once in two weeks.

It is advisable in the majority of cases to begin the treatment with a series of irrigations closely following one another. In some cases, however, when uncontrollable circumstances make it impossible to carry out the primary series of frequent irrigations, gratifying results have been

obtained from irrigations given but once a week for a prolonged interval of time.

During the entire period of treatment the patient's diet is rigidly controlled. As a rule any break in the prescribed diet is detectable by careful observation of the fecal residue in the return flow of the irrigating fluid. A mild cathartic is generally given before the introduction of the tube into the colon and before each irrigation to facilitate the removal of the feces through the tube. The irrigating tube is inserted gradually and very carefully into the colon with the left hand, while the right hand controls the inflow and outflow of the irrigating fluid. The tube may be advanced into the colon either during the inflow or outflow of water, but the colon must always be somewhat dilated with fluid during the time the tube is being fed into the colon. Unless the greatest of care and skill is exercised during this manipulation an abrasion or perforation of the colon wall may readily result. For this reason the insertion of the long or even medium tube into the colon should not be attempted by one not skilled in this technique. The quantity of water used for each irrigation varies from 2 to 4 gallons, warmed to body temperature. After each irrigation vigorous abdominal massage is resorted to, to stir up strong peristalsis and thus further aid in the evacuation of the colonic content. During the course of the irrigation treatment various alkaline and acid antiseptics as well as silver solutions are injected into the bowel through the tube.

Fresh cultures of *Bacillus acidophilus* are injected into the colon after each irrigation before withdrawal of the irrigating tube. Salicylates in large doses are also often introduced through the tube. Ordinarily warm water is used for the irrigations. In cases showing a heavy mucus return, a 2 per cent sodium carbonate solution is used to aid in separating the mucus from the bowel wall. As a rule, a minimum period of four to six weeks of intensive irrigation treatment in addition to the fullest use of every other means of treatment indicated is required in most cases before any appreciable clinical improvement becomes apparent.

Since the addition of this newer system of colonic irrigation treatment to the older forms of therapy in a selected group of cases of subacute and chronic arthritis with intestinal stasis the clinical results have, in the author's experience, been definitely improved.

No implication is made that colonic irrigations are a specific cure for subacute and chronic arthritis. While in some cases colonic irrigations are of definite value in the treatment of the disease, they should not be looked upon as the most important part of the treatment in all cases of chronic and subacute arthritis. Irrigations are but one of a large number of methods of treatment of a disease, which in the vast majority of instances requires the use of every method of attack indicated before a clinical cure can be effected, and the patient restored to economic usefulness.

The improved clinical results it would seem should be attributed to the system of irrigations as a whole. The ascertainment, however, of the exact value of each factor in this system of irrigations is a difficult matter and will require prolonged study with carefully checked controls in a large series of cases. It is also well to remember that the general physical condition, mental attitude of the patient, duration and extent of the disease at the time he presents himself to the physician are further variables which must be properly evaluated before any definite conclusions can be drawn as to the relative value of each factor in this method of treatment.

Up to the present time only a few facts have been determined through our combined clinical and roentgenologic observations. Although the facts so far determined have not as yet aided materially in explaining the beneficial clinical results obtained, we believe them to be of sufficient significance to justify a preliminary report of the work so far accomplished.

SECTION B—ROENTGENOLOGIC STUDIES—S. FINEMAN, M.D.

Since a combined clinical and roentgenologic study of colonic irrigations has not, in our knowledge, been hitherto carried out, it seemed advisable to investigate this form of treatment for the purpose of

demonstrating, if possible, the factors responsible for the good clinical results.

The difficulties which presented themselves in the course of this investigation were: (1) The impossibility of controlling variable factors inherent in the patients; (2) the necessity of controlling the other methods of treatment used in conjunction with the colonic irrigations; (3) the difficulty of establishing experimentally a standard artificial substitute in the colon which would fairly represent fecal stasis and against which the accurate effect of irrigations could be tested.

FIG. 1. Large colon with redundant sigmoid. It required 3½ quarts of solution to fill the entire colon.

It may be well to note that during this investigation no study was made of the effect of various cathartics on fecal stasis. It may be further noted that quite frequently in the course of routine roentgenologic observations, large fecal residues are seen in the colon even after preparation of the patient with drastic cathartics and enemas.

During the past year and a half we have examined roentgenologically the colons of 230 patients. Cleansing of the colon was intentionally omitted, prior to the examinations, in order to gain a clearer conception of the topographic arrangement and the degree of fecal stasis in the average office patient as he first presents himself for examination.

The majority of cases exhibited a colon particularly redundant in its transverse and sigmoid portions (Fig. 1). The flexures were nearly always sharp, and in many patients the cecum was found to be unusually large and situated low in the pelvis. In many cases the caliber of some sections of the large bowel and in some cases of the entire colon was exceptionally large (Fig. 2). Large fecal accumulations were very often seen in the sigmoid. In other cases both the sigmoid and descending colon contained many scybala, while in a smaller but still fairly large group of cases, the entire colon from rectum to cecum was filled with feces. On questioning the patients, in whose colons large fecal residues were seen, one learned that almost

FIG. 2. Colon showing narrow and spastic transverse and descending portions and a large pouch-like dilatation of the cecum and ascending colon.

all of these patients had been suffering from constipation for many years and that

FIG. 3. Normal colon, short sigmoid, obtuse flexures, high transverse colon, and high cecum. This patient has two natural bowel movements daily.

many of them were in the habit of using daily cathartics or enemas.

daily showed a very simple appearing colon (Fig. 3), with practically no elongated loops, with very obtuse flexures, and with a high and almost straight transverse colon.

The fact that the colon in constipated individuals was usually found to be of large caliber, redundant, and sharply angulated, does not imply that all such colons indicate the presence of deranged functions, as similar colons were found in a number of patients who were not obstipated. Apparently, the anatomic arrangement of the various loops of the colon is but one of the factors controlling the physiology of evacuation.

For the purpose of this study, it was necessary to establish as our standard a fairly uniform quantity of an opaque substance in the cecum and transverse colon upon which the efficiency of various enemas and irrigations could be observed. It is obvious that the remnants in the colon of a barium meal or of a mucilaginous barium enema are not identical in character nor are they strictly comparable to the contents of the colon in the condition of fecal stasis. For this reason it is proposed in later studies to use only very small quantities of opaque substances, which when intimately mixed with the

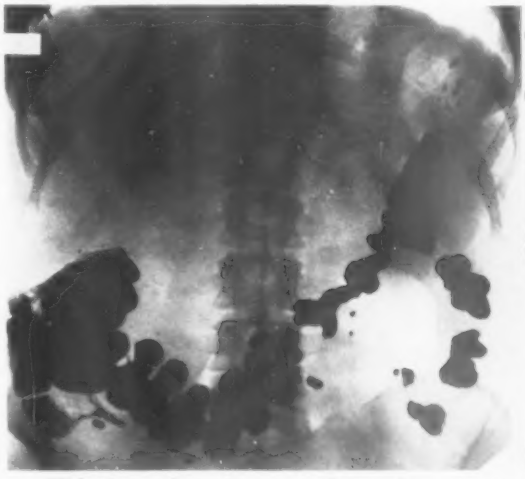

FIG. 4. This shows the appearance of the colon twenty-four hours after the ingestion of a pound of barium.

FIG. 5. This shows the cleansing result from a 2-quart soap-suds enema retained by the patient for fifteen minutes.

In contradistinction to these cases, a few patients who gave a history of normal bowel movements occurring once or twice

feces will make it possible to visualize the degree of colonic stasis but which will

in themselves be insufficient to form a considerable residue in the bowel. For the early and preliminary experiments, however, it seemed best to make use of large quantities of barium for the sake of easy recognition of the colon content. At first a 72-hour residue from a 4 ounce and later from an 8 ounce barium meal was used, but even in patients giving a definite history of long standing constipation, there is such a variation in the rapidity

FIG. 6. This shows the barium residue fifteen hours after the ingestion of one pound of barium.

FIG. 7. This shows the residue of barium after the evacuation of a 2-quart soap-suds enema retained for fifteen minutes.

FIG. 8. This shows the barium residue in the bowel fifteen hours after the ingestion of one pound of barium.

FIG. 9. This shows the colon of the same patient shown in Figure 8, and the poor result from an enema consisting of 2 quarts of warm water retained by the patient for fifteen minutes and then evacuated.

with which the barium is evacuated that a constant and sufficiently large barium residue in the cecum was frequently not found. In some cases of severe constipation of long standing, occurring in patients who had for years required a daily cathartic or enema, the ingestion of barium, even with the precaution of a previous elimination of cathartics and enemas for several days before the test, would result in as high as six evacuations in twenty-four hours and in a practically complete evacua-

FIG. 10. This shows the residue of barium remaining in the colon fifteen hours after the ingestion of one pound of barium.

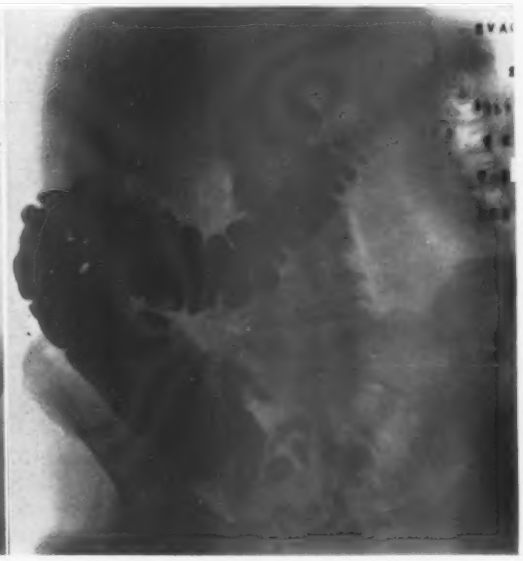

FIG. 11. This shows the poor cleansing result following a 2-quart saline enema and a 2-quart soap-suds enema, each of which was retained for fifteen minutes.

FIG. 12. This shows the fifteen-hour residue following the ingestion of one pound of barium.

FIG. 13. This shows the good cleansing effect following an irrigation in which the tube was inserted for a distance of 3 to 4 inches into the rectum. This is the same case shown in Figures 6 and 7 in which the cleansing result from a soap-suds enema was poor.

tion of the ingested barium in forty-eight hours. In some patients, subject only to occasional mild attacks of constipation, just the reverse was true. The ingestion of barium would be followed in these by a severe constipation. For the purposes of this study, therefore, it was thought best to adopt arbitrary standards of barium ingestion or injection into the colon. Two methods were employed. In one the efficiency of the enemas and irrigations was tested against a fifteen-hour residue of one pound of barium in water taken by mouth. The patients were not permitted the use of cathartics or enemas for three days prior to the test. By this method, there was found almost invariably a very large residue in the cecum and ascending colon.

The other method consisted in giving the patient an enema of standard composition consisting of a pound and a half of barium, one pint of mucilage, one pint of milk, and sufficient water to make up a two quart mixture. This enema was administered from a container suspended 35 inches above the horizontal trochoscope and the injection was almost always continued until the ileocecal valve would open. In the majority of cases it required two quarts of solution to fill the colon. In some cases, however, one quart of fluid, while in others as much as three quarts of fluid were necessary to fill the colon. The efficiency of the various enemas and irrigations was tested against

FIG. 14. This shows the barium residue in the bowel after the ingestion of one pound of barium.

FIG. 15. This shows the excellent cleansing result from a medium irrigation with 4 gallons of warm water. The tube was inserted for 37 inches into the colon. This is the same case shown in Figures 8, 9, 10 and 11, in which neither the administration of a 2-quart warm water enema nor a 2-quart saline enema followed by a 2-quart soap-suds enema resulted in a satisfactory cleansing of the bowel.

FIG. 16. Shows the irrigating tube inserted into a very redundant sigmoid. Twelve quarts of water were used for this irrigation. The roentgenogram shows the colon to have been thoroughly cleansed of the mucilaginous barium mixture only up to the site of the tip of the irrigating tube.

the residue remaining in the bowel after evacuation of this barium enema. With few exceptions, the residue was sufficient to outline the colon from cecum to sigmoid.

The method employed for cleansing the colon of these barium meal and enema residues were as follows:

(1) Two and four quart soap-suds enemas.

(2) Two and four quart saline enemas.

FIG. 17. Residue in colon after evacuation of a 2-quart mucilaginous barium enema.

FIG. 18. Shows effect of an attempted high irrigation. Position of tube in the colon during the irrigation was not determined.

(3) Two quart bicarbonate enemas.

(4) Two quart warm water enemas.

(5) The so-called "high" and "low" warm water irrigations.

(6) Bicarbonate irrigations.

(7) Saline irrigations.

(8) Soap-suds irrigations and combinations of these irrigations.

The cleansing effect of a two-quart soap-suds enema on the residue from the standard barium meal was tested in 29 cases. The enemas were given with the patient in the supine position, and in almost every instance, the patient was made to retain the enema for fifteen minutes. The soap-suds enemas as given for the purposes of experimentation are obviously far more effective than the soap-suds enema taken by the average patient at home (Figs. 4 and 5). In the first place, the amount of fluid used ordinarily by the patient is from one pint to one quart. In the second place, most patients administer the enemas to themselves while in the sitting posture; and thirdly, with the first onset of cramping, the patient usually immediately expels the enema.

After the evacuation of the soap-suds enemas administered in these experiments, a residue in the cecum and colon was found in 55 per cent of the cases tested (Figs. 6 and 7). In the patients with a history of constipation, the soap-suds enema failed to evacuate the bowel completely in 64 per cent of the cases. In those with no history of constipation the bowel in 36 per cent of the cases did not empty itself.

As already noted, in many cases a two quart soap-suds enema failed to cleanse the bowel completely. To some of these patients a second two quart soap-suds enema was then given immediately after the evacuation of the first enema, again retained for fifteen minutes, and again failed to evacuate the cecum and ascending colon completely.

The effect of bicarbonate and saline

enemas was found to be almost negligible in a small number of cases tested. Warm water enemas were found to act much better than the saline and bicarbonate enemas, but not so well as the soap-suds enemas (Figs. 8 and 9). In some cases, both saline and soap-suds enemas given in succession failed to evacuate the colon (Figs. 10 and 11).

The next experiments consisted in testing the effect of "low," "medium" and "high" irrigations on the cases which failed to evacuate the barium completely after the soap-suds enemas. Again the results varied considerably. In some cases the "low," "medium," and "high" irrigations removed less barium than the soap-suds enemas.

In a few cases in which a 2 per cent bicarbonate solution or normal saline was used for irrigation and in which the tube was introduced into the sigmoid, a great amount of barium still remained in the colon both at the end of irrigation as well as after evacuation which immediately followed the irrigation.

FIG. 19. Illustrates a very redundant sigmoid. The tip of the irrigating tube is in the transverse colon just proximal to the splenic flexure. Irrigating tube passed by our own technician.

In some instances in which the irrigating tube was proved to have entered the transverse colon and even into the cecum, there still remained a barium residue after irrigation and after evacuation. Judging from the experiments carried out so far, irrigations have not been demonstrated as always superior to the enemas in their evacuating effects. On the other hand, a number of cases which failed to respond to two quart saline enemas or four quart soap-suds enemas or even to a combination of both have shown a complete cleansing of the colon following both "low" (Figs. 12 and 13) and attempted "medium" and "high" (Figs. 14 and 15) irrigations. It was not possible to obtain roentgenograms of the position of the tube within the colon in all of these cases during attempted "medium" and "high" irrigations. As yet, therefore, final deductions concerning the necessity or advantages of

FIG. 20. Illustrates the position of the tip of the irrigating tube in the splenic flexure. The sigmoid colon is less redundant than the one shown in Figure 19. Irrigating tube passed by our own technician.

introducing the irrigating tube very far into the colon are not warranted. The evidence obtained so far shows that the insertion of the tube into the cecum does not necessarily result in a complete evacuation of the colonic barium content. On the other hand, a large residue remaining in the bowel fifteen hours after the ingestion of a pound of barium may be completely removed from the colon by an irrigation in which only a 4-inch tube is inserted into the rectum.

FIG. 21. Shows a fairly short and simple sigmoid. The tip of the irrigating tube has been passed for a considerable distance into the transverse colon by our own technician.

In another series of experiments two-quart soap-suds enemas and irrigations were tested against the residue remaining in the bowel after the evacuation of an enema of standardized composition referred to above. In these cases just as in those who had ingested the barium the effect of the soap-suds enemas varied. In some it resulted in a complete evacuation of the residue, in others the effect was almost negligible. The irrigations directed against these mucilaginous residues with the tube inserted only to the descending colon demonstrated effects different from those resulting from similar irrigations directed against barium meal residues. So far a thorough cleansing of the colon has not been demonstrated to occur in that portion of the colon not reached by the irrigating tube (Fig. 16). Even after the irrigation and after the tube is removed and the patient allowed to evacuate, there still remains a large barium residue in that portion of the colon. In several instances an almost complete evacuation of the mucilaginous barium residue was obtained after attempted "high" irrigations (Figs. 17 and 18). In these cases, however, the position of the tube was not roentgenographed and so conclusions regarding the relationship between the position of the tube and the result of the irrigation are not warranted. It is well known that the insertion of the tube far into the colon is not for the purpose of facilitating the introduction of the solution into the cecum. The water of the ordinary enema given through a short rectal enema can readily be made to reach the cecum. The introduction, therefore, of a tube into the transverse colon (Figs. 19, 20, 21 and 22) or

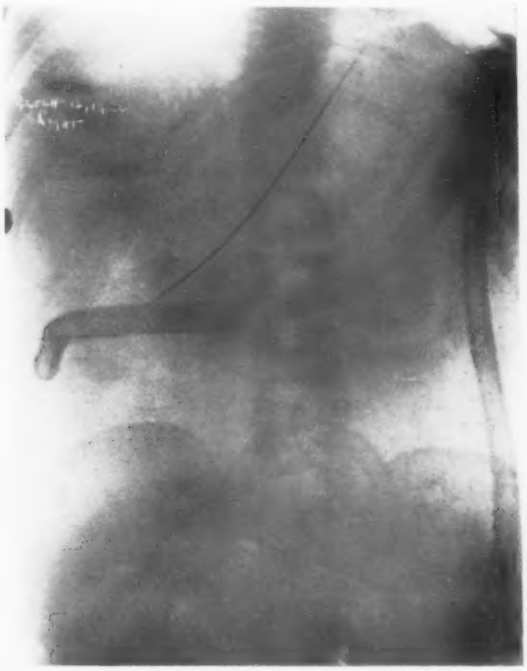

FIG. 22. Shows the tip of the irrigating tube to have reached to the hepatic flexure. Irrigating tube passed by Schellberg.

cecum must have some definite value to justify the procedure.*

In a few cases the tube was first inserted beyond the splenic flexure, after which a standard mucilaginous barium enema was injected through the tube, and then the tube was withdrawn. In some of these cases a very good evacuation of the colon followed in contradistinction to poor evacuations following the injection of similar

FIG. 23. Shows tip of irrigating tube in the cecum. Irrigating tube passed by Schellberg.

enemas given to other patients in the course of our routine work. On the other hand, in other cases the previous introduction of the tube did not result in a good evacuation of the mucilaginous enema. It may be that in certain cases the value of introducing the tube for a great distance into the colon lies in the resulting irritation of the bowel which is set up by the passage of the tube. Such repeated irritations result possibly in the development of greater intestinal tonus and subsequent improvement of elimination.

* Figures 19, 20 and 21 show irrigating tubes inserted by our own technicians under trying and unfavorable conditions in the roentgen-ray laboratory. Figures 22 and 23 show tubes passed by O. B. Schellberg while the patient was lying on the soft irrigating table and in the irrigating room to which he was accustomed. The surroundings of the roentgen-ray laboratory, strange both to the patient and technician, the hard roentgen-ray table, and the use of the portable irrigating apparatus make it exceedingly difficult to insert the tube as far into the colon as is possible with the patient lying relaxed on the soft mattress of the irrigating table.

Assuming that the insertion of the tube far into the colon during a colonic irrigation is of value, then it is important to determine the relative frequency with which the tube can be passed beyond the sigmoid and also whether the irrigating tube can be made to reach into the proximal portions of the colon, which are so often the site of colonic stasis and which has already been demonstrated as being frequently but little affected by irritant enemas.

In the course of routine irrigation treatments of the colon it is obviously not practical to determine the position of the tube in every instance. Under experimental conditions in the roentgen laboratory, a number of factors enter which disturb both the patient and the nurse. Neither one is accustomed to the strange surroundings. The patient is apprehensive and does not relax, making the insertion of the tube for any great distance into the colon a most difficult task even in the hands of the most experienced technician. In a fairly large number of cases in which previously no difficulty was experienced in passing the entire length of a 54 inch tube into the colon, it was found impossible, when an irrigation was attempted under experimental conditions, to pass the tube for more than 18 to 24 inches.

It seemed advisable, therefore, to test these points under the most ideal conditions possible. The next step, therefore, was an attempt to eliminate the two disturbing factors, namely, the nervousness of both the patient and the operator, by conducting a series of tests in the irrigating room familiar to both and in which there were better facilities for the irrigation. Fifteen consecutive cases were thus irrigated by Mr. Schellberg. The tube was demonstrated to have been inserted beyond the sigmoid-descendens junction of the colon in 13 of the 15 cases. The splenic flexure was reached once, the transverse colon 7 times. Once the tube reached to the hepatic flexure, and in one case the tip of the tube was demonstrated to be in the cecum. In each of these 13 cases from 50 to 58 inches of tubing was inserted into the colon. This series of experiments, as well as previous roentgenograms, revealed,

much to our surprise, that the attempt to reach beyond the sigmoid required in many instances an extraordinary length of tubing. In one case a 58 inch tube reached for a short distance only into the descending colon. It seems that in many individuals the sigmoid is either exceedingly long or else that the insertion of the tube causes it to stretch considerably in length. On the basis of these experiments it would seem that in order to reach the cecum in many cases, a 6 or 7 foot irrigating tube would be required.

The demonstration of the great frequency with which it is possible to insert the irrigating tube into the transverse colon does not necessarily imply that such is the case in the hands of inexperienced technicians. The tube may coil and kink in the rectum and sigmoid and nullify the value of the irrigation. Dangerous results such as severe trauma or puncture of the bowel may occur when the tube is inserted by one who has not had a careful and prolonged training in this work.

As a precautionary measure, for the purpose of discovering organic lesions of the colon which might contraindicate the insertion of a long tube, it is felt that every patient should have a preliminary roentgenologic examination of the colon. Furthermore, the roentgenograms of the colon assist the operator by supplying him with visual evidence of the topographic arrangement of the various loops of the colon.

If due consideration is given to these precautionary measures before "medium" or "high" irrigations are attempted the procedure loses its dangers and can be carried out with comparative safety, as shown by the fact that during the past two years approximately 12,000 irrigations have been carried out under the immediate supervision of one of the writers without a mishap.

SUMMARY

(1) Colonic irrigations of various types have been used by one of the writers for the past four years in the treatment of certain cases of subacute and chronic arthritis.

(2) Following the addition of this form of treatment to the older well-known therapy of the disease, the clinical results have been definitely improved.

(3) A combined clinical and roentgenologic study was undertaken for the purpose of discovering, if possible, the factors responsible for the clinical improvements obtained.

(4) One series of observations dealt with the gross appearance of the colon examined with the aid of a barium enema in a series of 235 ambulatory private patients. In the vast majority of these the colons were found to be very redundant and showed very acute flexures. In many, pouch-like dilatations of the cecum and ascending colon were noted. Large fecal accumulations practically filling the colon were seen often.

(5) The residues on which the effect of various enemas and irrigations were tested consisted both of the fifteen hour residue, following the ingestion of one pound of barium, and the amount of barium left in the colon after the evacuation of a mucilaginous barium enema of a standard formula.

(6) The effect of various types of enemas and irrigations was tested on these residues.

(7) Among the various enemas tested on barium meal residues, soap-suds enemas were found most often to produce the best results. However, in 64 per cent of constipated individuals and in 36 per cent of patients who gave no history of constipation, the soap-suds enema failed to cleanse the bowel completely.

(8) Both the "high" and "low" irrigations tested on similar barium residues, and on several occasions in the same individuals who failed to respond to the soap-suds enema, often produced a complete and thorough cleansing of the colon. In a few cases, neither the enemas nor the "low" or "high" irrigations, even with the tube in the cecum or transverse colon, could completely remove the barium residues.

(9) Soap-suds enemas tested on the residues of the barium mucilage enemas have resulted in complete evacuation of the residue in some instances and in a partial evacuation in others.

(10) "High" irrigations tested on the

residues from the barium mucilage enemas gave comparatively good results in a few cases. Roentgenograms of the position of the tube within the colon could not be made so that it cannot definitely be said that these were actually so-called "high" irrigations.

(11) In every instance where the effect of irrigations was tested on mucilaginous residues and in which the tube was roentgenographed *in situ*, the irrigation succeeded in completely cleansing the colon only up to that point in the bowel reached by the tip of the tube.

(12) It is emphasized that neither the barium meal residue nor the barium enema residue truly represent a fecal residue in the colon. Consequently the results of all of the experiments, while suggestive, need not necessarily truly interpret what actually happens in the bowel as a result of enemas or irrigations.

(13) In a series of 15 consecutive tests, the irrigating tube was passed beyond the sigmoid in 86 per cent of cases. It was proven that the cecum may be reached by the irrigating tube.

(14) The passage of the irrigating tube into the proximal half of the colon is not a dangerous procedure in the hands of an experienced technician working under ideal conditions and aided and forewarned by previous roentgenologic studies of the colon.

(15) From the roentgenologic studies carried out to date it has not as yet been possible to determine accurately the value of inserting the irrigating tube into the proximal colon.

(16) The only evidence obtained so far of the value of inserting a long tube reaching into the proximal colon during the irrigation, is that in some cases it appears to set up an improved contractility of the colon. The repeated irritations from the tube are possibly of value in improving the tonus of the colon and thus aiding in the prevention of colonic stasis.

The writers thank Mr. E. Rolleston, the manager of the Wappler Electric Company, for his courtesy in furnishing them with a complete roentgenographic apparatus for some of the experiments. They are also indebted to Mr. Schellberg for his coöperation in some of the experiments.

The writers also wish to express their appreciation to Drs. Imboden, LeWald, and Jaches for the many helpful suggestions given them.

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DISCUSSION

DR. JAMES T. CASE, Battle Creek, Mich. I would like to ask some questions. Did I understand that you always give a cathartic in connection with these irrigations? What is the cathartic, and how much?

DR. SNYDER. That varies in each individual case.

DR. CASE. Are any of these injections done under the fluoroscope?

DR. SNYDER. No, it is pretty hard to see the ordinary irrigating tube under the fluoroscope and we don't like to expose the patient too much. We hope to be able to obtain an opaque tube which will be sufficiently elastic for this type of work.

DR. CASE. I am extremely interested in this paper. The authors have shown slides which evidently show the accomplishment of something that I have always had the ambition to accomplish but haven't succeeded, and I would like very much to know how they got the tube up there. My only success in getting a tube up into the descending colon has been in a case of lues where the colon was practically converted into a nearly rigid tube, leading directly from the rectum right up to the splenic flexure. I suppose I might have gone farther in that case, but for the lack of a long enough tube as the authors have mentioned.

I certainly wish to testify to the value of thorough colonic cleansing in cases of arthritis of the types referred to. I have had some very striking results, but I have always felt that this discussion of high and low enemas was quite a futile discussion. At least 20,000 times we have been able to reach the cecum with about 2 quarts of an enema administered with the irrigating can approximately 35 inches

above the patient and the patient lying flat on the back. The cases where we have failed to do it have been cases of organic stricture.

So having succeeded in reaching the cecum, I rather apologized to myself for not being able to pass the tube any farther by saying it was unnecessary to pass it farther, and I would like to ask whether or not that is true. In attempting to pass the tube I have always been considerably deterred by an experience of one of our men who was using an instrument of that sort; he poked it through a diverticulum of the sigmoid. I had to operate in an emergency afterwards. Fortunately we saved the patient's life, but it certainly deterred us from efforts to do very much intracolonic manipulation for fear of puncturing a diverticulum. A previous roentgenogram in this case hadn't given any sign of diverticulosis of the colon.

Dr. David R. Bowen, Philadelphia. I have a personal slogan, which has been verified just now, that anything can happen. I still think there are some things that happen mighty seldom. I have tried most carefully in something more than 100 cases to pass the colon tube of varying sizes past the first bend of the sigmoid flexure. I never did it in a normal case. I have never failed to see the tube coil up; perhaps I didn't coil 57 inches of it; if I had, it might finally have gone around.

I still believe that this thing is very impractical, especially outside of perhaps one or two very experienced experts.

Dr. Leon T. LeWald, New York City. I would just like to emphasize what Dr. Snyder has brought out, the necessity of nobody attempting this procedure without a previous study of the colon as to its exact conformation.

For a good many years we have been gathering together anomalies of the colon and you never can tell in any way until you have made a careful study of the colon what type of colon you are going to deal with. That was brought out by Dr. Case. The presence of an indurated diverticulitis would contraindicate irrigation. On the other hand, I had some cases of multiple diverticula of the colon in which there was no evidence of any narrowing or inflammatory area in which I think that some attempt at keeping these diverticula cleansed by irrigation would have been a very proper procedure. In fact, I am trying to gather together some cases of that sort to have Dr. Snyder attempt this on even though it isn't a wise procedure in the treatment of multiple diverticula of the colon.

At the present time we have very little to offer the patient after we have made the diagnosis. They immediately ask what we are going to do about it. I know filling the diverticula with bismuth or barium by mouth administered two or three times a week is not going to cure or help these cases. I had one case which perforated while the diverticula were being treated. So I practically abandoned advising giving barium by mouth.

I think that irrigation is perhaps going to be the solution of this problem.

Dr. Snyder (closing). We have tried to bring out in the paper that we have used these long tubes in quite a series of cases for two years and a half or perhaps three years. We believed it was necessary to pass the long tube in order to get the clinical results, but since Dr. Fineman has been working with me on the roentgen question, it may be that we are going to learn that it isn't necessary to pass the tube so high. We are going to start another series of cases and treat them with all the factors the same except the length of the tube, and in that way we will be able to tell clinically whether the length of the tube is of benefit or not.

In regard to passing the tube, there is need for a good deal of practice and study. In our experience the nurse is not of much benefit to us unless she has had four to six months' training, at least. She eventually gets the feeling of the end of the tube and she knows by watching the inflow and outflow of water whether the tube is coiled or not. In the large majority of cases a nurse can pass the tube into the transverse colon, but only after considerable training.

So far as the clinical result is concerned, we have had a number of cases with diverticula. Of course every one of my cases are *x*-rayed before they are irrigated, and if the nurse knows that the diverticula are there, she naturally is more careful. To date we have not had an accident in irrigating cases complicated by the presence of diverticula in the colon.

Dr. Fineman (closing). The question was raised about the water reaching the cecum with the enema. That point is well covered in the paper. We did show very definitely in a number of cases in which where enemas of various types failed to evacuate the cecum that these same cases were evacuated by irrigation. That is the important point to bear in mind.

As to Dr. LeWald's question regarding the diverticula being a contraindication to irrigation, the implication was not that; what we meant to infer was that it was necessary to determine whether there were any obstructions such as inflammatory tumor associated with the diverticula or a malignant growth with ulceration, in which case the tube may be very readily made to perforate the bowel.

ROENTGEN DIAGNOSIS OF FOREIGN BODIES IN THE ESOPHAGUS*

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FOREIGN bodies lodge in the esophagus from one or more of a number of reasons: (1) because they are too large to pass; (2) because they become more or less imbedded in the mucous membrane; (3) because the lumen of the esophagus is narrowed by some other lesion and offers obstruction to the passage of even small bodies or of food, or (4) they may even perforate the esophagus and project into the peri-esophageal tissues.

The large foreign body, causing partial or complete obstruction of the esophagus and which lodges because of its size, is the common type in children and infants, while the small, slender type that becomes more or less imbedded in the mucous membrane is much more common in adults than the large obstructive type, and is seldom found in children.

The most common location for all esophageal foreign bodies is at or a little above the level of the suprasternal notch. This is true not only of the large foreign body, but also of the foreign body that becomes partly imbedded in the mucous membrane. The exception to this rule is the open safety pin which follows no rule as to the location where it will finally stop—in fact, I believe the majority of them lodge below the level of the suprasternal notch or pass on into the stomach.

Of the first type, the coin-shaped foreign body is the most common (Fig. 1). This includes coins from pennies to half dollars, buttons, campaign buttons, badges, tin whistles, etc. The open safety pin is almost as common as the coin and they vary in size from quite small to very large safety pins. The open end is usually upward but in several instances the open end was downward. In one of these, the pin probably opened after it had been swallowed—at any rate, the pin was bent and the point was partly missing, so that its closure was insecure. In another instance, the safety pin was regurgitated from the stomach into the esophagus, with the open end downward. In several cases there were more than one safety pin present (Fig. 2).

Small, metallic toys are found fairly frequently and then there is a miscellaneous group of irregularly-shaped objects. In the adult, a false tooth plate or other artificial denture is the common foreign body that lodges because of its size. Occasionally, large pieces of bone are found and in one patient the foreign body was a peach stone that produced complete obstruction at the level of the suprasternal notch.

Of the foreign bodies that lodge because a sharp point or projection becomes imbedded in the wall of the esophagus, the small fragment of bone heads the list. Straight pins are found occasionally but they usually lodge in the pharynx, when they start point downward. When they start head downward, they pass on through the gastrointestinal tract, as a rule. However, some years ago, Dr. Bowen found a straight pin lodged in the appendix of a young girl. A hair pin, with the closed end downward, lodged in the pharynx and esophagus of a two-weeks old baby and remained there for six weeks. It seemed to lodge there more because one of the prongs became imbedded in the pharynx rather than because of any obstruction to the closed end.

The perforating foreign body is, fortunately, rather rare. We have seen 2 cases in which small fragments of glass passed entirely through the esophageal wall into the tissues of the neck. In another, a thumb tack penetrated the posterior wall of the esophagus above the level of the suprasternal notch. Open safety pin points sometimes seem to project through the esophageal wall into the mediastinal areas.

When the lumen of the esophagus is narrowed by organic lesion, food particles, such as pieces of meat, are the intruders, as a rule. In one case, a grain of corn

* Read at the Twenty-seventh Annual Meeting, AMERICAN ROENTGEN RAY SOCIETY, Detroit, Mich., May 17–21, 1926.

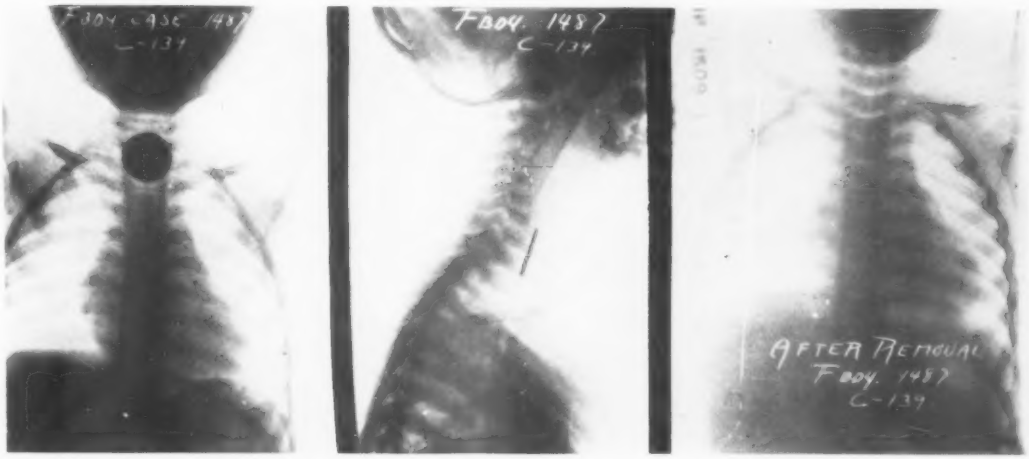

FIG. 1. A quarter at the level of the suprasternal notch; the most common location of esophageal foreign bodies.

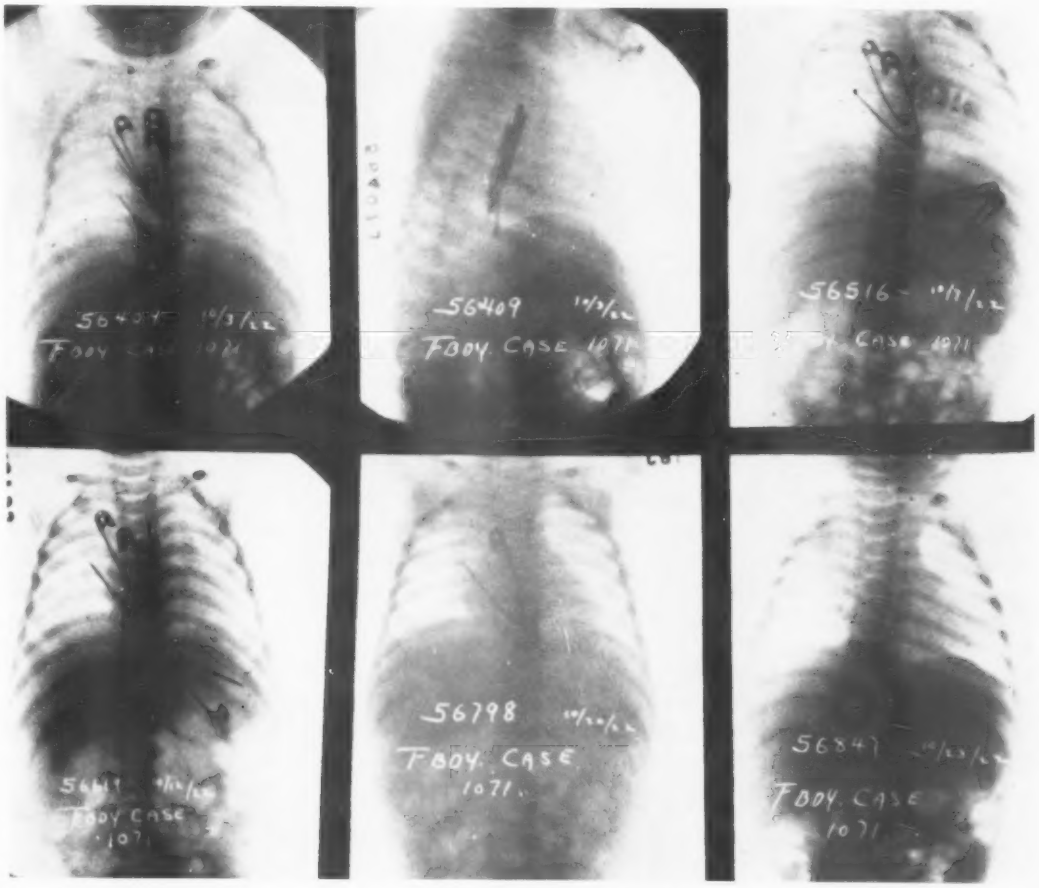

FIG. 2. Four large, open safety pins in the esophagus. Foreign body was not suspected. Illustrations show progress of treatment.

produced complete obstruction to the esophagus, and it so happened that at a lower level in the esophagus there was a second stricture, which would also have prevented the passage of food of the size of a grain of corn.

DIAGNOSIS AND LOCALIZATION

It is of the utmost importance to insist that the roentgenoscopic or roentgenographic study include the entire tract from the nasopharynx to the anus, and it is equally important to insist that all clothing be removed before the examination is made. Only the best quality of roentgenograms should be accepted. One should not depend only upon the roentgenoscope to exclude slightly opaque foreign bodies. On the other hand, it is the most important part of the study, in the case of the non-opaque variety. One should never make a negative diagnosis of foreign body from the roentgen examination alone.

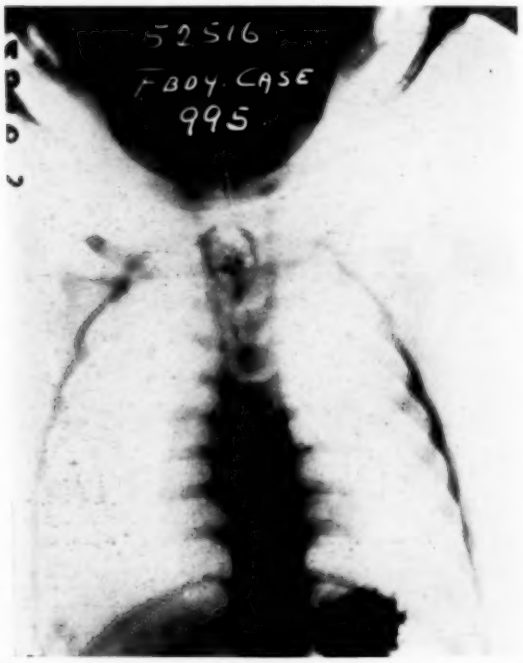

Fig. 3. A large non-opaque button at level of suprasternal notch. Note bismuth in thread holes.

The nature of the foreign body should be determined whenever possible, especially when it is dense enough to cast a shadow. Observations should be made from various angles to determine whether or not there are rough margins or sharp projections which might cause injury during the extraction operation.

The roentgen localization should be made shortly before the operation for removal because the foreign body sometimes shifts its position or disappears. It is also very important to make a roentgen study after the removal of the foreign body.

A foreign body in the esophagus lies with its greatest length in the long axis of the body, its width in the lateral direction, and its thickness anteroposteriorly. The open safety pin, for example, lies with the spring end either up or down and with the point to one side and the keeper to the other. The reverse of this is true with regard to the width of the foreign body when it is in the trachea, that is, in the trachea the keeper and point lie in the anteroposterior plane. In other words, the greatest width of the esophageal foreign body is in the lateral direction and of the tracheal foreign body in the anteroposterior direction. This constitutes a fairly satisfactory differential diagnosis for foreign bodies such as coins and open safety pins, from the mouth to the level of the tracheal bifurcation. We have, however, seen the flat side of a coin almost anteroposteriorly and the open safety pin with the keeper and point projecting laterally, when in a bronchus. They seem to rotate in leaving the trachea.

Regardless of the size or shape of the foreign body, one should make roentgenograms both anteroposteriorly and laterally. The lateral view must be good enough to give a definite shadow of the trachea and the anteroposterior view must show a definite shadow of the bifurcation of the trachea. When the foreign body is posterior to the trachea in the lateral view or in the median line below the level of the bifurcation of the trachea, it is clear that the foreign body is in the esophagus and not in the trachea or bronchi, but it must be remembered that the esophagus is a fairly movable organ and an irregularly shaped foreign body, such as a collar button, may have its shadow cover that of the trachea in both the anteroposterior and lateral views. In such case, even though the

foreign body be opaque, one must have the patient swallow bismuth mixture for final and accurate localization.

For the large, non-opaque foreign body we depend upon a fairly thick, watery mixture of bismuth subcarbonate to show either a filling defect or a deviation of the stream in either the anteroposterior or lateral direction or both. The larger the foreign body, as a rule, the greater is the resort to the capsule test in foreign bodies that lodge because they are too large to pass readily through the esophagus. In children, especially, we do not resort to the capsule method except when the child is sufficiently intelligent to cooperate.

The small, non-opaque foreign body (Fig. 4) that lodges because it becomes partly imbedded in the walls of the esophagus at times is easily found with a

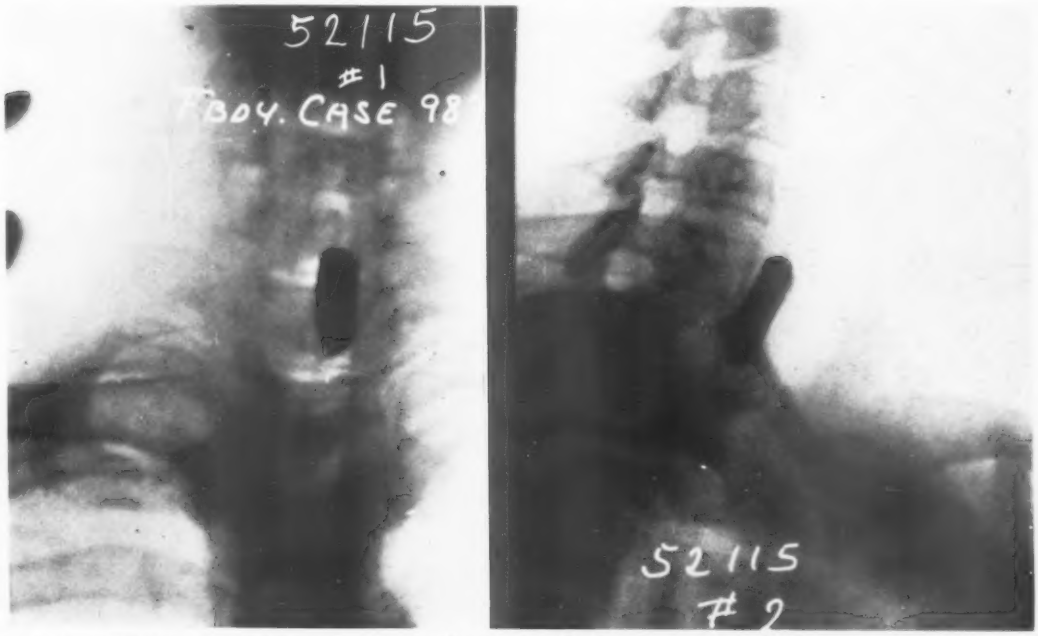

Fig. 4. A small fragment of bone in the esophagus. Its shadow is not seen, but it stops a #00 capsule filled with bismuth subcarbonate and holds it there until dissolved.

interference with swallowing, but liquids may pass fairly easily foreign bodies such as large non-opaque buttons. On two or more occasions, we have seen the thread holes of buttons take up the bismuth (Fig. 3), and we have on more than one occasion determined the presence of a foreign body in the esophagus by lateral views because the foreign body divided the mixture into an anterior and a posterior stream, while in the anteroposterior view the mixture seemed to pass in a fairly normal volume. A peach stone in an adult produced almost complete obstruction because its thickness was almost as great as its width and nearly filled the lumen of the esophagus. There is, of course, interference with swallowing of solids. We rarely watery bismuth mixture because some of the bismuth adheres to it. In the vast majority of instances, however, the foreign body is only a small splinter or fragment that will not retain enough bismuth to make a diagnosis easy. In such cases, we have the patient swallow a #00 capsule filled with bismuth subcarbonate after it is made thoroughly wet. The patient is directed also to take one large swallow of water with the capsule to wash it down. Wetting the capsule thoroughly before attempting to swallow it is important because a dry capsule may lodge and adhere for a long time to almost any portion of the esophageal wall. One must remember also that it is rather common for a capsule of this size to hesitate in passing through

the diaphragm opening, so that it is possibly not a reliable test for foreign bodies in the extreme lower end of the esophagus.

If there is a foreign body present, the capsule will stop when it comes in contact with the foreign body and usually remain there for a considerable length of time, frequently until the capsule dissolves. If often happens that the capsule will stay there even though the patient drinks water

Fig. 5. A small slender piece of glass has gone through the pharyngeal wall into the neck. Note the forward displacement of the trachea by pus; also bubble of gas behind the larynx in the infected area.

or bismuth mixture; in fact, in some instances of small foreign body, a second capsule will be stopped by the first capsule and both will stay there until dissolved. If there is definite discomfort as a result of the foreign body, and its presence is not revealed by the liquid mixture of bismuth subcarbonate, then one should start with a small capsule and increase the size, if necessary. This is advisable because a small capsule would naturally produce less trauma in passing or coming in contact with the foreign body than a large capsule. The #00 sized capsule seems to be large enough in any case.

When there is a history of glass having been swallowed, it is unwise to use capsules or any other hard substance for fear of completing an incomplete perforation. We feel also that it is unwise to have the patient swallow any opaque test meal that will not dissolve if it lodges at the site of the foreign body. We especially advise against large pledgets of cotton impregnated with bismuth or barium. The second foreign body may eventually be responsible for further penetration of the first foreign body because it adheres to the foreign body and is subject to the prolonged influence of esophageal peristalsis.

Of the perforating type (Fig. 5), we have seen 2 cases in which the foreign body, a piece of glass, passed completely through the esophageal wall and lodged in the tissues of the neck. In each instance, the foreign body gave a fairly distinct shadow but the striking appearance was due to the peri-esophageal infection displacing the esophagus forward, so that the bismuth stream was well anterior to the cervical vertebrae. In one of these, the abscess was drained by external surgical operation; the other, through an incision in the posterior wall of the pharynx. In another case, a thumb tack perforated the wall of the esophagus but, of course, the head remained in the esophagus. This, too, produced a retropharyngeal and peri-esophageal infection.

Then there is the perforating type (Fig. 6) that perforates by the slow process of corrosion, aided by pressure and infection. So far, all such cases that we have seen have been foreign bodies of considerable size and of long sojourn. A gold collar button was discovered first by Dr. A. C. Christie when he made a roentgenographic study to determine the cause of lung trouble that had existed for nearly a year. The child had been seen by consultants and had been treated for some time by an asthma specialist, but no roentgen study had been suggested until the child was practically dead, in fact, it did die before Dr. Jackson had any opportunity to attempt removal of the foreign body or even to have a gastrostomy done. The collar button had corroded through the anterior wall of the esophagus into the posterior wall of the trachea so that part of the child's food, liquids, went from the esophagus into the trachea and bronchi. He had a chronic, infectious pneumonitis of the aspiration or foreign body type. The child really died of starvation and lung infection.

In another instance, a half dollar remained in the esophagus for five years.

During that time it corroded through the lateral wall of the esophagus, through the pleura and left lung into the left bronchus. There was infection of the pleura and left lung with an empyema necessitatis which pointed over the left chest wall at the level of or a little below the diaphragm. The empyema was drained surgically but the patient died before any attempt could be made at removal. In this instance, salt to that of barium in the study of esophageal foreign bodies for the reason that bismuth seems to have some little therapeutic value in cases of injury to the esophagus.

Foreign bodies such as ordinary food (Fig. 7) are common in cases that have strictures of the esophagus from some other cause. The foreign body may be as small as a grain of corn or a rather large

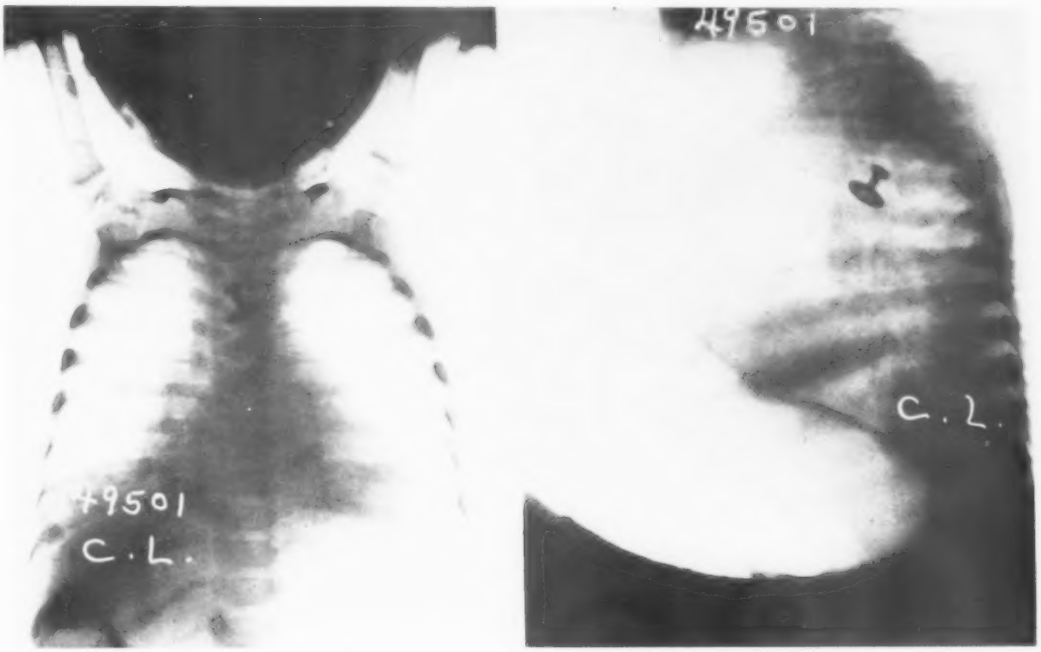

FIG. 6. Gold collar button in esophagus nine months. It perforated the anterior wall of the esophagus and the posterior wall of the trachea.

the boy said he had swallowed a half dollar and his father kept insisting that such was the case and finally demanded a roentgen study. The boy was five years of age at the time of the accident.

On the other hand, we had one case in which a false tooth plate had been in the esophagus at the level of the suprasternal notch for seventeen years without perforating the esophagus. In this case, a stricture developed so that the patient was driven to the throat doctor because he could no longer swallow even liquids.

In all of these perforating foreign bodies, the intruder has been dense enough to cast a positive shadow.

Jackson prefers the use of a bismuth bolus of food, such as meat. The diagnosis is an easy one from the clinical point of view, because obstruction is complete, but we can, by means of the rays and a small quantity of bismuth mixture, determine the approximate size of the foreign body, its location, and perhaps show more than one stricture. In one case, the same bolus of food caused complete obstruction at two distinct and widely separated points in the esophagus. In other cases, we have been able to demonstrate more than one stricture of small caliber.

We have made reference to some of the complications that may arise as the result of a foreign body in the esophagus but it is well to pursue this thought a little further.

The complications and sequelae that may and at times do arise are briefly as follows: (1) acute hunger and thirst become distressing factors when the foreign body is large enough to produce complete, acute obstruction; (2) aspiration of particles of food into the trachea and bronchi, due to esophageal regurgitation, occurs in cases of partial obstruction, as well as in cases of complete obstruction, and, sooner or later, causes bronchial or pulmonary infection; (3) injury to the esophageal wall may be directly due to the foreign body or to an unwise effort to dislodge or push down the foreign body either with or without the aid of the esophagoscope. Such injury may be followed by stricture formation and even complete cicatricial obstruction; (4) peri-esophageal infection may result from trauma to peri-esophageal structures without complete perforation, especially when the foreign body is below the level of the suprasternal notch; the pleura is susceptible to such injury, and (5) infection usually follows penetrating wounds of the esophagus, and when it occurs in the neck, the condition is essentially an emergency requiring surgical interference.

FIG. 7. A bolus of food causing complete obstruction at the site of stricture of the esophagus. Note how bismuth has spread "down over" the foreign body.

We have purposely avoided the question of diagnosis from the clinical point of view, but we must admit that we sometimes do lean heavily upon the history and symptoms to help us arrive at a definite diagnosis in the case of non-opaque foreign bodies in the esophagus. On the other hand, diagnosis from history, symptoms and physical signs alone is rarely justifiable.

TECHNIQUE

Just a word as to the technique in the case of children. It is absolutely essential to make roentgenographic exposures at such speed that the motion of breathing or struggling will not cause a blur in the shadows. It is sometimes difficult to get children to take the bismuth mixture but one usually has enough assistants to hold the child so that a small quantity of the mixture may be poured into the mouth from a spoon, or, as suggested by Pancoast, one can pass a soft rubber catheter or a small stomach tube through the nose into the upper esophagus and then introduce the bismuth mixture by means of a syringe.

Whether the patient be a child or adult, the anteroposterior exposure must be sufficient to give good detail in the shadows of the lower dorsal vertebrae or it will not be sufficient to show foreign bodies in this location even though they be metallic.

The capsule test for small non-opaque foreign bodies must always be made with the patient in the erect posture in order that the force of gravity may help in the passage of the capsule.

The material upon which this paper is based has been obtained from the Bronchoscopic Clinic of Dr. Jackson at the Jefferson Hospital.

ROENTGENOLOGICAL DEMONSTRATION OF A DERMOID CYST WITH EXTENSIVE DISPLACEMENT OF THE GASTROINTESTINAL TRACT

BY HERMAN FRIED, M.D.

NEW YORK CITY

DURING a roentgenological examination of the gastrointestinal tract, we very often discover extrinsic conditions which give rise to symptoms belonging to the alimentary canal. Alteration of position or displacement of the various organs of this canal are some of the most frequent changes found in such conditions. But in this case the altered positions of the organs were so extensive that it became difficult to correlate and interpret the different films of the series and hence it was difficult to reach a diagnosis. In order to overcome this difficulty it was necessary to draw a composite sketch of the entire series, for only in this way was it possible to synthesize all films into one picture (Fig. 1).

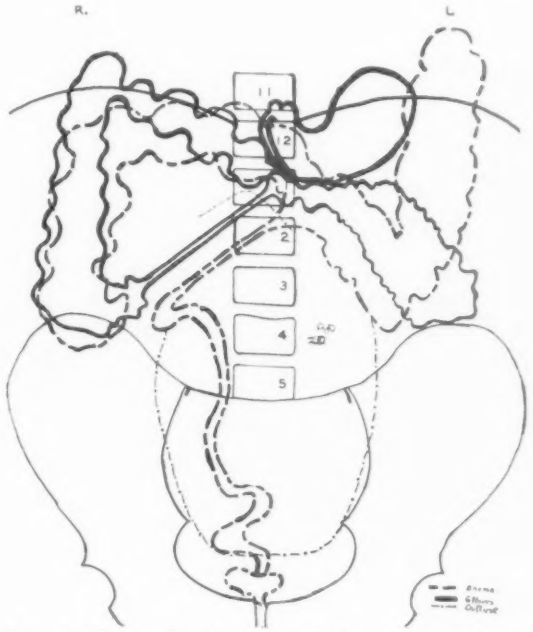

FIG. 1. Composite drawing of the entire series of roentgenograms to show and synthesize the relation of the gastrointestinal tract and dermoid cyst.

CASE RECORD

Miss K., unmarried; family and previous history not essential. Menstrual history, always complained of dysmenorrhea, otherwise regular. For about nine months she suffered from gastric distress, nausea and frequent vomiting. Several days previous to this examination, she had a severe attack of pain on the right side of the abdomen and was taken to a hospital where she was relieved of the pain and was told that an operation was absolutely necessary. She decided to delay the operation until a roentgen examination determined the nature of her trouble.

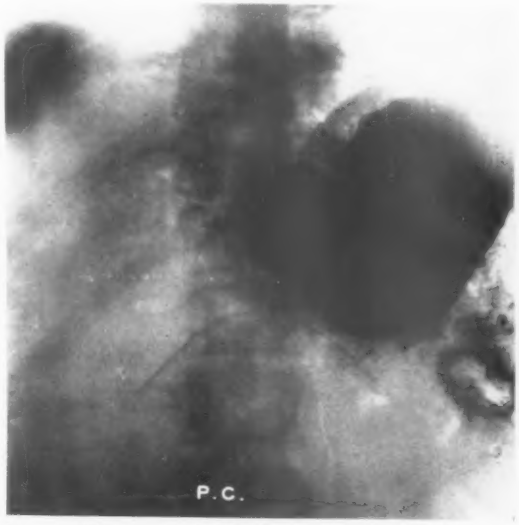

FIG. 2. The stomach displaced up and to the left. Below is the semilunar line of infiltration and thickened wall of the cyst. To the left of the 4th lumbar vertebra are shadows of teeth.

Physical examination revealed heart and lungs normal, abdomen distended, tenderness on pressure in the right lumbar and right inguinal region. A rounded mass was felt three fingers above the umbilicus but owing to the tense abdominal wall, physical examination was unsatisfactory.

Roentgen findings after ingestion of barium meal shows (Fig. 2) the stomach pushed up and to the left, below the stomach a semilunar linear shadow appears which shows an infiltrated thickened or calcified wall of the mass which was felt by physical examination. To the left of the fourth lumbar vertebra is a group of shadows irregular in form and size, but which on close inspection resemble teeth.

FIG. 3. Small intestines are pushed up and to the left. Lower end of ileum, from Meckel's diverticulum to ileocecal junction, is strung across. Meckel's diverticulum is seen in front of 1st lumbar vertebra in the form of a pouch.

FIG. 4. Cecum, hepatic and splenic flexures contain small residue. The descending colon is fairly well filled.

FIG. 5. Barium enema showing sigmoid and lower part of descending colon pushed out to the right forming a loop.

FIG. 6. Barium enema film taken higher up. Loop of colon is shown and seems twisted above loop. Upper part of the descending, transverse and ascending colon is filled.

Tumors containing such structures are most often found in that class of teratoma known as cysts.

Figure 3 shows the small intestines displaced upward and to the left; the lower end of the ileum from Meckel's diverticulum to the ileocecal junction is strung or stretched across. Meckel's diverticulum, which is here seen opposite the first lumbar vertebra in the form of a pouch, is usually about one to two feet above the ileocecal junction. It is the remains of the vitelline duct and plays an important part in the cause of intestinal obstruction.

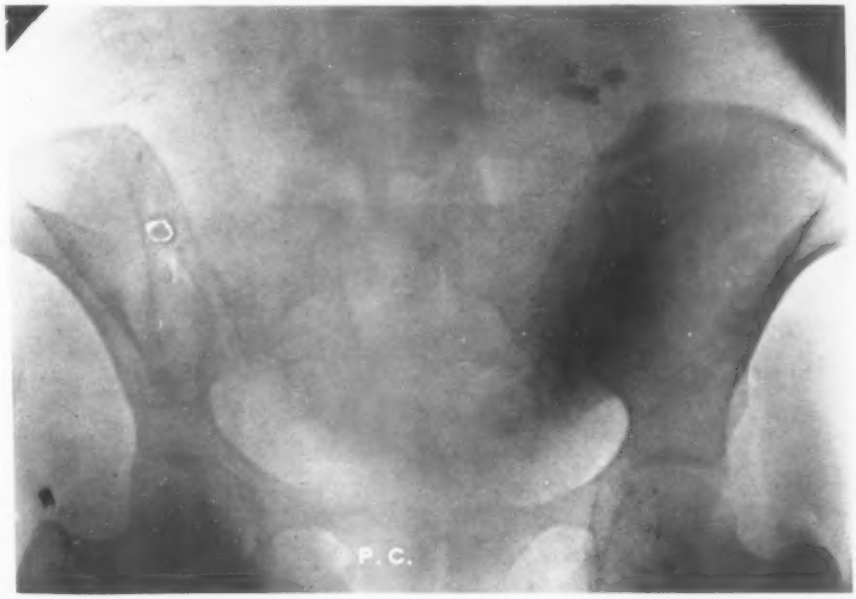

FIG. 7. A distinct shadow of a rounded tumor, the base extends across the entire pelvis.

This structure is rarely if ever demonstrated roentgenologically. The visualization of this structure became possible in this case by the displacement of the coils of the ileum and jejunum, thus exposing the lower part of the ileum which empties into the cecum, an organ which we all know is usually fixed and immobile.

Figure 4 is the 24-hour film which again shows the semilunar linear shadow as well as the tooth-like structures as previously demonstrated. Here we see the hepatic and splenic flexures containing small residue, and the descending colon fairly well filled with the opaque meal.

Figure 5 represents the barium enema, and shows the lower end of the bowel pushed out to the right and forming a loop, carrying barium upward. Figure 6 demonstrates the same enema, but the film was taken higher up. It visualizes the upper part of the descending, transverse and ascending colon filled with barium. Here again the rounded linear shadow is shown as before.

Figure 7 is a film taken after the bowels have been cleared by castor oil and a soapsuds clysma. There is a distinct shadow of a rounded tumor, the base of which extends across the entire pelvis. The tooth-like shadows are here very clearly visualized.

Diagnosis. Dermoid cyst, most probably emanating from the left ovary displacing the lower part of the gastrointestinal tract to the right and upward, and the upper part of the gastrointestinal tract to the left and upward. The cyst extends from the pelvis to the first lumbar vertebra.

Operation performed by Dr. Louis Friedman at the French Hospital, New York City, March 22, 1926, revealed a multilocular dermoid cyst of the left ovary occupying the greater part of the abdominal cavity and in size greater than a man's head. It contained almost a gallon of fluid which was aspirated. The tumor was then freed from adhering bands by which it was attached to the various organs it displaced. The appendix was removed and the abdomen was closed. The patient recovered uneventfully.

The pathologist reported a multilocular dermoid cyst containing a gallon of fluid, several teeth, many pieces of irregular bone tissue, a large amount of hair, fat, sebaceous material and structures resembling intestinal

tissue. The upper circumscribing covering of the cyst was thickened and infiltrated, the base was solid tissue of mixed growth.

SUMMARY

This case demonstrates that a diagnosis of dermoid cyst which very often presents difficulties to the clinician will at times be aided by roentgenography.

It shows to what extraordinary size a cyst of this type is capable of growing without producing very marked subjective symptoms. Dermoid tumors grow slowly and may be latent for a number of years, and then give rise to symptoms only when there is a period of sexual activity or when complicated by inflammation or adhesions, or when it interferes with the functions of contiguous organs by pressure or displacement. In this case the cyst was more or less bound down by inflammatory bands, and certainly interfered with the digestive tube by the extensive displacements it caused.

From a roentgenological point of view this case is also of particular interest because it was possible to visualize by the roentgen ray, Meckel's diverticulum. This structure cannot, as a rule, be demonstrated roentgenologically except when freed by displacement from coils of the small intestines.

ROENTGEN-RAY TREATMENT OF LESIONS OF THE LYMPHOID TISSUE

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Harper Hospital

DETROIT, MICHIGAN

THE high sensitiveness of the lymphatic cells and their derivatives toward radiation was early recognized. Heineke,[1] experimenting with small animals, such as mice and guinea pigs, demonstrated as early as 1904 that the administration of a severe dose of roentgen rays over the entire body of the animal results in the destruction of the lymphatic system within twenty-four hours, with death of the experimental animal. If the irradiation was milder, so that the animals did not die, the lymphocytes reappeared in the blood and in a short period they completely regenerated. The same observation was made shortly afterwards by Aubertin and Beaujard,[2] and by Warthin.[3] In 1915 Murphy and Morton,[4] in experimenting with cancer in mice, for the first time observed that the regeneration of the lymphocytes is followed for a short period by increase in the number of the lymphocytes above the normal. They also found that, in a few cases, such stimulation of the lymphocytes resulted from the primary action of small doses of roentgen rays. In 1919 Thomas, Taylor and Witherbee, and Nakahara[5] proved that the stimulation of the lymphocytes follows the administration of small doses of roentgen rays of low penetration as a constant phenomenon, always accompanied by hyperactivity of the lymphoid centers. The lymphocytosis as a rule reaches its height on the fourth day following irradiation and then gradually subsides.

As a result of the above fundamental experiments, which later were supplemented by many others, three facts are now well established:

1. There is extreme sensitivity of the lymphocytic elements: of both the circulating and the elements of the lymphoid centers, towards radiation. Too much radiation produces rapid destruction of these elements.

2. There is great regenerative and recuperative power of the lymphoid tissues.

3. There is a definite stimulation of the lymphocytic elements by small doses of roentgen rays.

These three factors, as we shall see, are of great importance in the radiation therapy of all conditions of the lymphoid tissues, and they are directly responsible for the many surprisingly good results obtained. They also explain to us why certain diseases, as, for example, tuberculosis or acute and chronic infections, respond more readily to irradiation when occurring in lymphoid tissues, than in any other part of the body.

METHOD OF TREATMENT

It follows from the above experiments that in the treatment of lesions of the lymphoid tissues by means of roentgen rays, two methods might be followed: (1) the destructive irradiation, and (2) the stimulative irradiaton.

In order better to comprehend the indications of these two methods, it seems advisable to consider first the problem of the biological reactions produced by the two forms of irradiation.

BIOLOGICAL REACTIONS

There was a great deal of discussion during the past decade with regard to the action of the roentgen rays on the pathological cells, more especially on the tumor cells. While numerous authors maintained that the destruction of the pathological cells is the primary and most important action of the roentgen rays, others rather inclined to the view that the production of a biological reaction in the normal tissues is the primary effect and that the damaging of the pathological cells is only secondary to this reaction. At the present time the opinion expressed by Ewing[6] that both factors are concerned in the radiation effect simultaneously, seems to gain more and more ground. This is how Ewing expresses himself: "The radiation effects are direct and injurious upon the tumor cells, and indirect and destructive through secondary factors."

By studying the radiation effects in connection with the two above methods of treatment, we soon arrive at the conclusion that, while the destructive irradiation manifests its action mostly by the direct and injurious effect on the pathological cells themselves, the stimulative irradiation will act by means of the secondary factors. It follows from this, that in treating lesions of the lymphoid tissues, destructive irradiation will be required in the cases where primary destructive action is needed, that is, in case of bulky tumors (neoplastic and their relative processes), while the stimulative irradiation will have a more beneficial effect on the inflammatory conditions (acute and chronic inflammations), where the secondary reaction, i.e., the protective mechanism of the local tissues, is of more importance.

In both forms of irradiation there is, however, also a general effect, manifesting itself in a reaction, which may be called the immunization process. There are two factors concerned in this process: (*a*) The antibodies of the organism produced or stimulated by the action of substances liberated from destroyed pathological cells; (*b*) the lymphocyte stimulated to overaction by different biological, chemical and physical agents.

(*a*) The antibody production, if we may call it so, is always the result of the direct destructive action of some agents, mostly roentgen rays and radium, on the pathological cells. A disintegration of the cells with liberation of large quantities of chemical substances (toxins) follows, which in turn leads to an excessive formation of protective material (antibodies). That such a process exists is conclusively brought out by the serological experiments of Heidenhain and Fried,[7] in the case of the radiation therapy of acute coccus infections. These experiments prove that the exposure of acute infections to roentgen rays is followed by a direct increase in the bacteriolytic power of the blood, lasting for a period of from four to six days. The pus removed from the irradiated lesion during the same period remains sterile. Helber and Linser[8] demonstrated a similar process for the destruction of leucocytes and they called the toxin isolated leucotoxin. Caspari,[9] applying the same principle for the tumor cells, arrived at the conclusion that the disintegrating cells liberate similar substances, which he calls necrohormones. In our opinion, it is too hazardous as yet to assume for the tumors the existence of such specific substances,

as for example, the antibodies of Heidenhain. On the other hand, it cannot be denied that a process of stimulation due directly to the substances of cell destruction is in course. This process may be similar to the one produced by the implantation of homologous living tissues, such as introduced by Bashford[10] or by the injecting of autolysates or other biological agents, where the resistant state of the organism is increased by the indirect stimulation of antibody formation. A detailed study of the effects of the roentgen rays on the antibody formation was made also by Hektoen.[11]

(*b*) There is a more exact knowledge with regard to the part the lymphocytes play in increasing the resistance mechanism of the body. Thus Murphy and Morton[12] in experimenting with cancer of mice proved beyond doubt that the "taking" of the grafted cancers is in direct relation with the lymphocytic state: When there is lymphemia the grafts "take" and grow very rapidly, while in the case of lymphocytic stimulation the cancer does not grow.

There are numerous methods of producing a stimulation of the lymphocytes, and of course all these methods are in direct relation with the increase of the resistance of the organism as a whole. Nakahara[13] succeeded in producing a stimulation of the lymphocytes in mice by injecting olive oil transperitoneally. Murphy and Sturm, and Nakahara[14] increased the lymphocytosis by the action of heat, and Aschenheim and Meyer,[15] Clark,[16] and Sonne,[17] by the action of the sun's rays or concentrated light. Since Murphy and Morton[4] first observed that an increase in the number of circulating lymphocytes in mice can be produced by the application of very small doses of roentgen rays of low penetration, a number of experiments and observations have been made on this subject by Thomas, Taylor and Witherbee,[5] Mottram,[18] Russ and his coworkers,[19] Lacassagne and Samssonow,[20] and especially by Murphy and Nakahara and their coworkers.[21] These latter, in a series of experiments on mice, showed that irradiation is capable of producing: (1) a local lymphocytic infiltration around the irradiated tumor, and (2) an increase in the number of circulating lymphocytes, due to an increase in the proliferative activity of the lymphoid organs.

From this the conclusion is derived that the lymphocyte is the most important factor in producing the so-called resistant state and that the effects of the roentgen rays depend in the first instance on the mobilization of the lymphocytes. Recently Carrel[22] brought another important contribution to the problem when he succeeded in stimulating the growth of the fibroblasts *in vitro* by the presence of lymphocyte cultures, thus furnishing evidence that the connective tissue formation around the irradiated tumor is the direct result of the lymphocytic infiltration produced by the roentgen rays.

The establishment of the above facts, as we shall see, will greatly facilitate our task in interpreting phenomena observed during the roentgen treatment of the lesions of the lymphoid tissues, and will enable us to arrive at some definite conclusions with regard to the method of treatment to be used in the particular instances.

CLASSIFICATION OF THE LESIONS OF LYMPHOID TISSUES

The lesions of lymphoid tissues can be classified into three main groups:

A. Inflammatory conditions.

B. Neoplastic conditions.

C. Conditions occupying an intermediate position between the two.

A. CONDITIONS INFLAMMATORY IN ORIGIN

1. *Infectious lymphadenitis.*

(*a*) *Acute and subacute lymphadenitis.*

The most common form of infection is the acute lymphadenitis following coccus infections, also after diphtheria, typhoid fever, scarlet fever, chancre, etc. It is only recently that the radiation therapy of these conditions has been tried. The initiative is due to Heidenhain and Fried,[7] who accidentally observed the rapid disappearance of two postoperative suppurations of several months' duration following a diagnostic roentgen examination. Since that time they have extended the treatment to about 250 cases and their results have

been most satisfying. The process was taken up later by a few others with equally gratifying results. We began the radiation therapy of acute infections about seven years ago with the treatment of acute pneumonias, and the results were so favorable that we later extended the treatment to other acute and subacute infections (mostly coccus infections) where other therapeutic methods failed. At the present time we treat all forms of infections. Judging from the results already obtained, we believe that radiation therapy will soon be one of the most important factors, second only to surgery, in the treatment of these conditions. This is especially true as regards the acute and subacute infections of the lymph nodes, where the results are apparently the best. Holzknecht[23] estimates the good results obtained in the roentgen treatment of all forms of coccus infections as between 50 to 90 per cent, with the highest percentage in the treatment of the infection of the lymph nodes.

The treatment consists in applying the smallest dose of roentgen rays ever used in roentgen therapy. Only 10 to 15 per cent of a skin unit dose is administered, the larger doses remaining without effect or being directly damaging. We use hard rays of 0.13– A wave length (200 kv. with 1 mm. Cu and 1 mm. Al as filters), but since the depth dose is here of no importance, rays of any penetration may be used. (In the very severe, not transportable pneumonias, we now use the very soft rays of the portable apparatus.)

In about one-third of the cases, one single dose is sufficient, the improvement being rapid. In the rest we repeat the treatment at one week intervals for two to three treatments. In cases where there is evidence of abscess formation, it is necessary to supplement radiation therapy with surgical procedures.

There can be no doubt that the effect of such minimal doses of roentgen rays is in the first place stimulative to local tissue reactions. At least the often observed fulminant disappearance by crisis of large infiltrations seems to indicate such a process. But in addition to this local stimulative action there is also a general immunization process, such as serologically proven by Heidenhain and Fried. According to Holzknecht[23], it is probable that some highly sensitive leucocytes are destroyed even by these minimal doses of roentgen rays, thus releasing antitoxins and bacteriolysins they contain "by virtue of constitutional and pathologic factors."

In order better to illustrate our methods of treatment, we will give in each instance detailed case reports with complete follow-up histories, selecting of course the cases which give the most typical picture of the method used.

Case 1. H. I., aged three years, female, white.

History of Present Illness: In May, 1925, patient contracted scarlet fever which ran its usual course. 6–22–25. Patient developed sore throat and swelling in the right side of the neck. This was treated by the house physician by conservative methods for a period of two weeks. 7–6–25. The lesion on the neck was incised and a great deal of pus evacuated. Following the incision the lesion on the neck continued to enlarge and there was considerable discharge from its surface. There was an intermittent temperature between 90 to 102°F.

The condition of patient became gradually worse, so that on 7–26–25 she was admitted to Children's Hospital. Here again the lesion was incised but no pus was found at this time. The usual conservative methods were applied for a period of about ten days, with the lesion progressing.

8–8–25. Patient was referred for radiation therapy.

Physical Examination 8–8–25: There is a large ulcerative lesion the size of a palm, on the right side of the neck, extending from the clavicle to the mastoid process and from the midline to the posterior border of the sternocleidomastoid muscle (Fig. 1). The muscles of the neck, as well as the lower pole of the parotid gland, and the larger portion of the submaxillary gland, are freely exposed. There is a pronounced discharge and granulation of the surface of the lesion. There is edema of the larynx. Temperature 101°; general condition very poor. However no other organic lesion can be detected.

Diagnosis: Septic ulcerative lymphadenitis of the right side of the neck, following scarlet fever infection.

Treatment: Stimulative irradiation: 10 to 15 per cent skin unit dose over the lesion, the

normal tissues around the lesion being included in the irradiated area.

Quality of Roentgen Rays: 0.137 wave A length (200 kv., 1 mm. Cu plus 1 mm. Al as filters).

Technique of Exposure: 8–8–25. One area over the entire right side of the neck; field 20 × 20 cm., water cooled tube 25 ma., 5 min. = 125 ma-min., skin target distance, 80 cm. This makes 15 per cent skin unit dose on the surface of the lesion. (Our standard skin unit dose under the above conditions and by using a water cooled tube, is 625 ma-min. for 70 cm. skin target distance; that is, 816 ma-min. for 80 cm. skin target distance.)

Three days following the irradiation the patient developed pneumonia of the right upper lobe, and could not report for further irradiation until August 22.

Re-examination 8–22–25: The lesion reduced to half of its original size; surface clean, very little discharge.

Treatment repeated by using the same technique as above. Stimulation dose: 15 per cent skin unit dose on the surface of the lesion.

8–26–25: Temperature dropped down to normal and has since remained normal.

9–16–25: Lesion entirely healed (Fig. 2). General condition of patient normal.

There can be no doubt that the remarkable improvement in the above case is due to the roentgen therapy. All conservative, as well as surgical methods, had failed in producing any improvement in the condition of the lesion. As soon as radiation therapy was introduced the lesion began to heal rapidly and within six weeks there was a *restitutio ad integrum.*

(b) Chronic Lymphadenitis. Simple Lymphoma.

This condition as a rule is the result of a chronic irritation produced mostly by bacterial agents. Thus we often observe chronic lymphadenitis of the lymph nodes of the neck in persons exhibiting a focal infection within the mouth, such as infected tonsils or carious teeth, or of the mesenteric lymph nodes following an intestinal infection, especially in cases of chronic appendicitis and duodenal ulcers of long duration; or we may observe an enlargement of the inguinal lymph nodes following chronic ulcers of the leg, or finally, in any other possible infection. The clinical benign course of the disease, together with the typical histological findings of the removed lymph node, makes the diagnosis in the majority of cases a rather easy task.

In treating such conditions by radiation therapy, our aim is to destroy the excessive

FIG. 1. Septic ulcerative lymphadenitis of the right side of the neck following scarlet fever.

FIG. 2. Same as Figure 1. Six weeks following roentgen therapy. Lesion healed.

lymphatic hyperplasia produced by the, in most cases, obscure irritative agent. In doing so, there is, however, a peculiar behavior of the benign lymphomas which immediately attracts our attention. This is the remarkably resistant state to radiation of the lymphocyte forming the lymphoma. Ewing[6] has already pointed to this fact in connection with the treatment of hyperplasia of the tonsils, and he thinks that the resistance of the lymphocytes is due to their arrangement in the organized structure of the lymph node. Indeed, whenever this structure is destroyed as for example in neoplasia, a nutritional instability develops which together with the poor differentiation of the cells by virtue of their rapid multiplication, makes the lymphocyte very vulnerable to irradiation. But when the organized structure of the lymph node is maintained, even in the hyperplastic processes, a heavier irradiation is necessary in order to destroy the lymphocyte, than one would expect according to our observations made on the roentgen effects on lymphocytes when in circulating state, or in neoplastic transformation. Thus, the lymphocyte in its structure within the lymph nodes is so resistant, that, as Quick and Cutler[24] have shown in the case of radiation therapy of carcinoma metastasis to the lymph nodes, the roentgen dose which leads to a complete necrosis of the carcinoma cells, leaves the lymph follicles entirely intact in their structure.

Of course, in treating simple lymphomas, our aim is not to destroy the enlarged lymph nodes entirely, but to produce a *restitutio ad integrum*. Consequently, the doses administered need not be so large as, for example, the doses of Quick and Cutler. As a rule, a dose of 50 to 70 per cent skin unit dose will suffice in the majority of the cases to make the lymphoma entirely disappear. However, because of the resistant state of the lymphocyte, as mentioned above, the disappearance will not be so spectacular, as for example, in the case of lymphosarcoma; but will extend over a period of several weeks, sometimes even months. In a few instances a repetition of the treatment is necessary. This is done about six to eight weeks following the first treatment. In none of our cases have we been forced to administer more than two treatments. The quality of the radiation is 0.137 A, that is, hard rays produced by 200 kv. filtered through 1 mm. Cu and 1 mm. Al. Of course, rays of lower penetration such as used by Witherbee[25] in the treatment of lymphomas following tonsillar infections, will also do, but a great number of treatments repeated at frequent intervals will be necessary in order to produce the same results.

In some instances the differential diagnosis of simple lymphomas from more malignant conditions of the lymph nodes, such as lymphosarcoma, pseudoleucemia and Hodgkin's disease, especially in their earlier stages, becomes impossible or at least uncertain. It is best to follow in such cases the method of treatment advised for the malignant lymphomas. In the case of a questionable tuberculosis, the treatment as practised for that disease is applied.

Case II. V. D. A., aged eighteen, female, white.

History of Present Illness. 1-13-25. Patient admitted to Harper Hospital for operation for chronic appendicitis. Examination before the operation revealed nothing of pathological interest except for the findings of chronic appendicitis.

Operative Findings. 1-24-25. Appendix 4 inches long, kinked and twisted in its middle and somewhat edematous. Appendectomy with crushing and inversion of stump. Uterus is infantile and adnexa appear to be normal. The mesenteric lymph nodes are enlarged from 1 to 3 cm. in diameter, probably inflammatory in origin.

Patient made an uneventful recovery. However, at the reexamination, 4-20-25, patient still complained of pain in the abdomen, the symptoms being similar to those previous to the operation. Her menstrual periods were regular and of usual duration. There was some loss of weight. Patient was advised to have radiation therapy over the mesenteric lymph nodes.

Diagnosis. Chronic lymphadenitis following appendicitis of long duration.

Treatment. Light destructive irradiation, 50 to 60 per cent skin unit dose over the mesenteric lymph nodes.

Quality of Roentgen Rays. 0.137 A wave

length (200 kv., 1 mm. Cu plus 1 mm. Al as filters).

4–20–25. One area over abdomen anteriorly. The pelvic organs (ovaries) heavily protected by lead. Field 20 × 20 cm., water cooled tube, 25 ma., 20 min. = 500 ma-min., skin target distance, 70 cm., 80 per cent skin unit dose on the skin of the anterior abdominal wall.

About three weeks following the irradiation the symptoms disappeared and the patient has since remained symptomless. She has gained weight, and her general condition is normal. There were no menstrual disturbances following the radiation therapy.

CASE III. R. B., aged eleven, male, white.

History of Present Illness. Since January, 1924, patient has complained of severe pain in the upper abdomen. There was loss of weight and at times a slight increase in the temperature. In August, 1924, he was operated on for tumor masses in the abdomen. A left rectus incision was done, 4 inches long, beginning 1 inch above the umbilicus. The exploratory examination showed enlargement of the abdominal lymph nodes from 1 to 4 cm. in diameter, with no other pathological condition of the abdomen. The enlargement of the lymph nodes was diagnosed as simple hyperplasia.

Since the symptoms did not disappear following the operation 11–23–24 patient was referred for radiation therapy.

Physical Examination 11–24–24. There is enlargement of practically all the lymph nodes, viz., inguinal, axillary, supraclavicular, cervical and submaxillary lymph nodes; the enlargements varying from 1 to 2 cm. in diameter. The lymph nodes are hard but not painful on manipulation. There is an impression of several small masses palpable in the upper abdomen, corresponding to the enlarged abdominal lymph nodes found at the time of the operation.

Blood Count. R. B. C., 4,800,000; W. B. C. 10,000; P. 64 per cent; S. L. 27 per cent; L. L. 7 per cent; Tr. 2 per cent.

Urine examination negative. Temperature normal.

Examination of the internal organs revealed nothing of pathological interest.

Diagnosis. Status thymico-lymphaticus with general hyperplasia of the lymphoid tissues, more pronounced in the abdominal lymph nodes.

Treatment. Light destructive irradiation, 50 to 60 per cent skin unit dose over the enlarged lymph nodes and thymus.

Quality of roentgen rays. 0.137 A wave length (200 kv., 1 mm. Cu plus 1 mm. Al as filters).

Technique of Exposure. 11–24–24. One area over abdomen anteriorly, including both inguinal regions. Field 20 × 30 cm.

11–25–24: One area over abdomen posteriorly. Left suprarenal region heavily protected. Field 20 × 20 cm.

11–26–24: One area over each axilla. Field 10 × 10 cm.

11–28–24: One area over each side of the neck, submaxillary, cervical, supra- and infraclavicular lymph nodes. The thymus was also included in the irradiation. Field 20 × 20 cm. Larynx and thyroid gland well protected.

Since roentgen examination of the chest revealed no enlargement of the mediastinal lymph nodes, these were not exposed to radiation.

A 60 per cent skin unit surface dose for the large fields, and a 70 per cent skin unit surface dose for the small fields, was given over the above areas. The abdominal lymph nodes were cross-fired through 2 fields. Water cooled tube: 25 ma., 15 min., 375 ma-min. skin target distance = 70 cm. for the large fields and skin target distance = 65 cm. for the small fields.

There was very little reaction following the treatment.

About four weeks following the irradiation all enlargements of the lymph nodes disappeared, and the patient has since remained symptomless. His general condition at the present time is normal.

2. *Tuberculous Lymphadenitis.*

The lesion produced in the lymphatic tissue by the tubercle bacillus may be either (*a*) specific granulomatous change with exudation and caseation, or (*b*) hyperplastic lymphadenitis manifesting itself in a marked hyperplasia of the reticuloendothelial cells with a pronounced tendency toward fibrosis. On account of Sternberg's[26] belief that Hodgkin's disease is a tuberculous process, the hyperplastic lymphadenitis is included by some authors in the group of Hodgkin's disease as one of its sub-varieties. The results of radiation therapy, as we shall see, oppose such a conception of the problem.

(*a*) *Typical Tuberculous Granuloma.* Recent experiments of Ritter and Moje[27] have definitely laid down the principles of the roentgen treatment of this condition. Ritter and Moje proved (1) that radiation does not kill the tubercle bacillus, and (2) that the action of the roentgen rays on

tuberculous tissues is indirect by means of the stimulative reaction of the normal tissues. An increased lymphocytosis is produced around the tuberculous focus which leads to connective tissue formation and thus to the fibrosis and calcification of the lesion. It follows from this that in treating tuberculous granulomata the best results are obtained from the administration of small doses of roentgen rays. A stimulation of the defense mechanism around the lesion, as well as that of the general organism, ensues. The optimum dose ranges between 15 to 40 per cent skin unit dose; a dose larger than 40 per cent as a rule produces more damage than good.

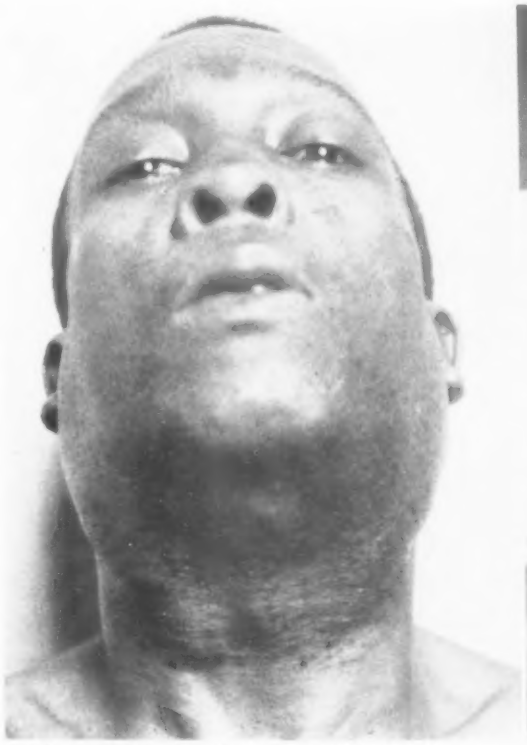

FIG. 3. Large tuberculous lymphadenitis; typical granuloma of both sides of neck.

FIG. 4. Same as Figure 3. One year after numerous roentgen treatments. Lesion healed.

In superficial lesions medium soft roentgen rays of 0.2 to 0.3 A wave length (produced by 135 kv. peak, and 3 to 4 mm. Al as filters) are preferable, while hard, penetrating rays of 0.1 to 0.15 A (produced by 200 kv. peak, with 1 mm. Cu plus 1 mm. Al as filters) should be used for the deep seated or very large lesions. In the case of medium rays, the treatments can be repeated at one to three week intervals, while in the case of the hard rays it is best to wait about four to six weeks before re-treating. If there is pus formation, surgical incision or puncture of the lymph node should supplement the radiation therapy. By using the above methods of exposure the results obtained in the treatment of the typical tuberculous lymphomas are so gratifying, that we are justified in using radiation therapy in preference to all other methods of treatment.

CASE IV. C. O., aged twenty-two, male, colored.

History of Present Illness. Since 1921 patient has been treated in various hospitals for tuberculosis of the lungs, complicated with tuberculous granuloma of the cervical lymph nodes. While his lung condition seemed to remain stationary, the enlargement of the lymph nodes on both sides of the neck was gradually progressing. In April, 1924, the enlarged lymph nodes on the right side of the

neck were surgically removed. There was a fistula formation following this operation which persisted. During the last few months the enlargement of the lymph nodes became so pronounced that the patient, because of the marked pressure on the trachea, had difficulty in breathing.

Physical Examination. 5–7–25. There is enormous enlargement of the lymph nodes on both sides of the neck. Practically all of the cervical, submaxillary and supraclavicular lymph nodes are enlarged, some of them being as large as 8 to 10 cm. in diameter (Fig. 3). There is a fistula on the right side of the neck in the place of an old incision, draining a greenish-yellow pus. There is no enlargement of the lymph nodes of the rest of the body. The roentgen examination of the chest shows a definite infiltration of the right apex, with bilateral thickening of the apical pleura. Temperature varies from 98 to 101°F. General condition fair.

Blood Count. R. B. C. 3,700,000; W. B. C. 19,000; P. 54 per cent; S. L. 35 per cent; L. L. 5 per cent; Tr. 2 per cent. Urine examination negative. Wassermann negative.

A lymph node removed for biopsy 5–3–25 shows typical tuberculous granuloma.

Diagnosis. Large tuberculous lymphadenitis of both sides of the neck, with definite infiltration of the right apex.

Treatment. Stimulative irradiation, 15 to 30 per cent skin unit dose over all the enlarged pathological lymph nodes.

Quality of Roentgen Rays. 0.137 Å wave length (200 kv., 1 mm. Cu plus 1 mm. Al as filters).

Technique of Exposure. 5–7–25. One area over each side of neck covering all enlarged pathological lymph nodes. Field 20 × 20 cm. Water cooled tube, 25 ma., 10 min. = 250 ma-min., skin target distance, 80 cm. This makes a 30 per cent skin unit dose on the surface of the skin.

The treatment was repeated at intervals of from four to six weeks for a period of over one year.

There was a gradual decrease in the size of the enlargements of the lymph nodes until practically all lesions disappeared (Fig. 4). Patient is still under treatment for the pulmonary condition.

(*b*) *Hyperplastic Lymphadenitis.* Because of the prominence of the reticulo-endothelial cells which are somewhat less sensitive to irradiation, a more intensive therapy is necessary in treating these lesions. A dose of from 70 to 90 per cent skin unit dose, which is similar to the dose administered in Hodgkin's disease, is advisable. In order to produce a large depth dose it is best to use rays of higher penetration. The enlarged lymph nodes as a rule disappear within six to eight weeks following the irradiation and only in a few instances is it necessary to repeat the treatment. However, since hyperplastic tuberculosis has a tendency to spread from one group of lymph nodes to another group, it is of advantage to extend the treatment from the beginning to the entire lymphatic system, as practised in the case of malignant lymphomas.

It was repeatedly suggested that hyperplastic lymphadenitis and Hodgkin's disease are processes, if not identical, at least closely related. However, the fact that the majority of our cases of hyperplastic lymphadenitis treated during the past four years remained well, while most of the Hodgkin's granulomas treated during the same period, in spite of all methods of treatments used, died, makes us believe that the two conditions are distinct entities, although the similarity in their histological appearance, and especially their common way of spreading, might indicate some sort of relationship between them.

CASE V. O' N. M., aged fifty, female, white.

History of Present Illness. In November, 1923, patient first noticed enlargement of the lymph nodes in the right submaxillary region following an attack of grippe. She did not pay much attention to this but later the swelling spread to other lymph nodes of the cervical region and also to the supraclavicular region. In February, 1924, the lymph nodes of the right axillary region started to enlarge.

Physical Examination. 3–24–24. There is enlargement of the lymph nodes of both submaxillary, cervical and supraclavicular regions, the nodes being from 1 to 5 cm. in diameter. There is also slight enlargement of the lymph nodes in the right axilla: from 1 to 2 cm. in diameter. The lymph nodes of the rest of the body are apparently not involved. There are no masses palpable within the abdomen. The roentgen examination of the chest shows no enlargement of the mediastinal lymph nodes. There are, however, numerous irregular calcified areas, disseminated over the upper third of both lung fields, and there is calcification of the lower cervical lymph nodes on the left

side, indicating the presence of an old healed tuberculous process.

Temperature and pulse normal. Urine examination negative.

Blood Count. R. B. C. 4,400,000; W. B. C. 11,000; P. 94 per cent; S. L. 4 per cent; Mo. 1 per cent; Eo. 1 per cent; Hgl. 70 per cent.

General condition good, no loss of weight.

A lymph node removed for biopsy from the neck shows hyperplastic tuberculosis (Dr. P. F. Morse) (Figs. 5 and 6).

Treatment. Intensive irradiation, 70 to 90 per cent skin unit dose over the entire lymphatic system, mediastinum and abdominal lymph nodes.

Quality of Roentgen Rays. 0.142 A wave length (205 kv., 1 mm. Cu plus 1 mm. Al as filters. The apparent difference in the wave length of the roentgen rays here and in the previous cases is due to the fact that two different transformers were used).

Technique of Exposure.

3–24–24: One area over each submaxillary, cervical, supra- and infraclavicular regions. Field 20 × 20 cm. (larynx and thyroid gland well protected).

3–25–24: One area over each axilla. Field 15 × 15 cm.

3–26–24: One area over both popliteal and inguinal regions. Field 15 × 15 cm.

3–27–24: One area over both cubital regions. Field 10 × 10 cm.

3–28–24: One area over mediastinum posteriorly, and one area anteriorly. Field 10 × 15 cm. (lungs well protected).

3–29–24: One area over abdomen posteriorly. Field 20 × 30 cm.

3–30–24: One area over abdomen, right anterior oblique. Field 20 × 30 cm.

3–31–24: One area over abdomen, left anterior oblique. Field 20 × 30 cm.

An 80 per cent skin unit surface dose for the large fields, and a 90 per cent skin unit dose for the smaller fields was given over the above areas. The mediastinal lymph nodes were cross-fired through two, and the abdominal lymph nodes through three fields. Air-cooled tube, 4 ma., 400 ma-min. (100 min.) for the large fields, and 450 ma-min. (112 min.) for the small fields. Skin target distance = 50 cm.*

All the enlargements of the lymph nodes disappeared within six to eight weeks following the treatment. Patient continues well.

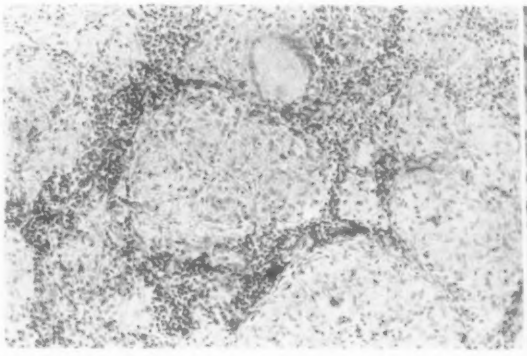

FIG. 5. Hyperplastic tuberculosis of lymph node (low power).

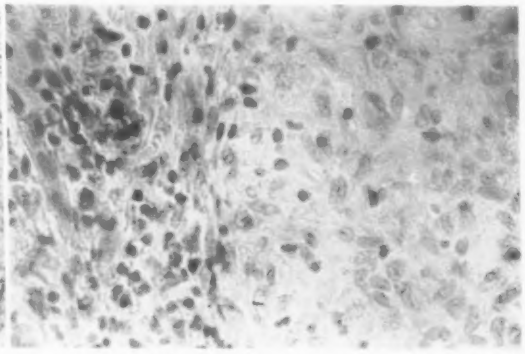

FIG. 6. Hyperplastic tuberculosis of lymph node (high power). Note similarity of cells to those in Hodgkin's disease.

The roentgen treatment of other chronic inflammations of the lymph nodes, as for example, actinomycosis, is based on the same principles as the treatment of tuberculosis, and consequently, the same method of exposure is used. For experimental purposes we have treated also syphilitic enlargements of the lymph nodes, and have obtained the same rate of reduction following the radiation therapy as in tuberculosis. In practice, the treatment of syphilitic lymphadenitis of course has to be done by the more efficient specific methods.

B. CONDITIONS NEOPLASTIC IN ORIGIN

The lymphomatous conditions, neoplastic in origin, may be primary or secondary. Secondary neoplasms are car-

* Our standards for the air-cooled tube by using the above factors are: 500 ma-min. for 50 cm. skin target distance. This makes 980 ma-min. for 70 cm. skin target distance, as compared with 625 ma-min. of the water-cooled tube for the same distance. The apparent discrepancy of 30 to 35 per cent is due to the more severe biologic reaction produced by the massive rays of the water-cooled tube.

cinoma, sarcoma or any other form of malignancy, spreading by the way of lymphatic permeation.

The primary tumors may originate either from the proliferation of the lymphocyte, such as lymphosarcoma or from the proliferation of the reticulo-endothelial cells, e.g., large round cell or reticulum cell sarcoma, Hodgkin's sarcoma, endothelioma, or finally from the proliferation of any other less defined cell element represented in the lymphoid tissues, as for example, in small round cell or spindle cell sarcoma, etc. Since the treatment of all these neoplastic conditions does not differ from the radiation therapy as applied for malignancies with other localizations, no detailed description of the method employed will be given here. However, the lymphosarcoma, large round cell or reticulum cell sarcoma and the Hodgkin's sarcoma, on account of their relationship to other lesions, having the progressive enlargement of lymphoid tissues as their main characteristic, will be discussed, together with those lesions in the group which follows:

C. CONDITIONS OCCUPYING AN INTERMEDIATE POSITION BETWEEN A AND B

This group includes a number of lesions of the lymphoid tissues, such as lymphatic leucemia, pseudoleucemia, leucosarcoma and Hodgkin's disease, which because of lack of etiology cannot be classified either as true inflammatory conditions or as true neoplasms, although clinically and pathologically they may show characteristics of both. Lymphosarcoma, large round cell or reticulum cell sarcoma and Hodgkin's sarcoma are also included. Because of the very close relationship of all these lesions, and especially because of the possible transformation of one process into another, it was repeatedly suggested during the past two decades that they be considered as clinical and pathological manifestations of a single disease of a genetic unity. Although such a view of the problem would greatly simplify matters, considerable difficulty is encountered as to the nature of the original lesion. Thus Warthin,[28] Mallory,[29] and Levin[30] would prefer the neoplastic conception, while Bunting and Yates,[31] Billings and Rosenow,[32] and Webster[33] are more inclined to the inflammatory point of view.

Simonds[34] who made a very elaborate review of the entire literature on Hodgkin's disease, in examining the evidence brought in support of the genetic unity of the above processes, arrived at the conclusion that: "Since etiology is universally recognized as the logical basis for the classification of disease, and since we do not yet know the exciting cause of any of these obscure lesions of lymphoid tissue, it seems best to adopt Ewing's[35] view and maintain clear histopathologic distinctions between the different forms of lymph gland enlargements until we know their origin." Since the histopathologic differentiation has a great advantage also from the point of view of determining the response of the different processes toward radiation therapy, it is best also for our purpose to follow Ewing's method of classification.

In studying the radiosensitiveness of each particular process, however, one cannot escape the impression that there is a definite similarity in the behavior of some of these lesions towards radiation. According to this similarity in the radiation response, we could place all lymphomatous conditions in two groups: (*a*) lymphosarcoma, lymphatic leucemia, pseudoleucemia, and leucosarcoma, on one side, and (*b*) Hodgkin's disease, Hodgkin's sarcoma and reticulum celled sarcoma on the other side. The distinction into the two groups coincides in an interesting way with the histogenetic differentiation according to which all proliferative processes arising from the lymphoid tissues are either of lymphocytic or reticulo-endothelial origin. Thus a lymphocytic cell proliferation is observed in lymphosarcoma, lymphatic leucemia, pseudoleucemia and leucosarcoma, while the reticulo-endothelial cell proliferation dominates the histologic picture in Hodgkin's disease, Hodgkin's sarcoma and reticulum cell sarcoma.

(*a*) The lymphocytic cell proliferative processes may show all types of cell proliferation from the simple hyperplasia (benign lymphocytoma) through all phases

of neoplastic transformation (lymphatic leucemia, pseudoleucemia) to the true neoplasia (lymphosarcoma, leucosarcoma). But in all these processes the proliferation as a whole remains localized to the lymphocyte (typical and atypical) and no other cell activity complicates the histologic structure. This monophasic cell activity is a most important feature responsible for both the roentgenological and histopathological similarity of all lymphocytic cell proliferative processes.

(*b*) As regards the conditions where the reticulo-endothelial proliferation forms the main characteristic of the histological picture, especially in Hodgkin's disease and Hodgkin's sarcoma, the type of the cell activity is not always so clear. At the beginning stage of the disease often a hyperplasia of several cell elements, such as of lymphocytes, reticulo-endothelial cells and leucocytes is observed. But even later, when the proliferation of the reticulo-endothelial cells becomes the predominating histopathological picture of the disease, a closer scrutinization will reveal that the cell activity is more complicated. It may be mentioned here that this heterogeneous aspect of the cell activity is one of the main reasons why Hodgkin's disease and its related conditions are so often placed among the true inflammations, especially by Sternberg[26] and his followers. From the point of view of radiation therapy, the heterogeneous cell activity is dominated by the less radiosensitive reticulo-endothelial cell element. Thus, even in the very early stages of Hodgkin's disease, where the lymphatic hyperplasia forms the main histologic characteristics, because of the presence of reticulo-endothelial cells, the rate of reduction in the size of the lesion irradiated is much slower than would be the case in pure lymphocytic cell proliferations. In the later stages of the disease, as well as in the case of Hodgkin's sarcoma, the rate of the reduction in the size of the tumor manifestations is determined purely by the radiosensitivity of the reticulo-endothelial cell elements.

In comparing the behavior of the two above groups towards the same amount of radiation, we find that the lymphocytic cell proliferative processes as a rule show a spectacular response (tumors sometimes melt away within a few hours, and even the largest masses entirely disappeared within eight to ten days), while the processes where the reticulo-endothelial cells form the predominating feature of the disease display a much slower reaction (several weeks or months are necessary for the entire disappearance of the tumor manifestation). It is unnecessary to say that the processes included within either of the groups show a uniform radiation response. Thus tumors of equal size of lymphosarcoma, pseudoleucemia or lymphatic leucemia will disappear at the same rate within the time unit, while Hodgkin's sarcoma will show the same slow rate of reduction as the tumefactions of Hodgkin's disease. This behavior of the two groups towards radiation is so typical, that as we[36] have shown elsewhere, it can often be used for the purpose of differential diagnosis.

GENERAL PRINCIPLES OF ROENTGEN TREATMENT

In the roentgen treatment of the lymphomatous conditions included within this group, two main principles have to guide us: (1) The treatment should be as extensive as possible, and (2) intensive radiation (hard rays) should be used.

(1) Since all lesions, having a progressive enlargement of the lymphoid tissues as their main characteristic have the tendency to extend from their primary focus very early to the entire lymphatic system, as well as to some of the abdominal organs (spleen, liver, gastrointestinal tract, etc.), a local treatment of the manifest tumor masses, without treating the distant extensions of the disease, would be of only little avail. Indeed, in our first cases of lymphosarcomas, where we treated only the local manifestations of the disease, new masses later appeared in some distant lymph node groups or abdominal organs, and the patients died as a result of these new manifestations of the disease. Since that time we have introduced the generalized treatment extending, as we shall see, to the entire lymphatic system and all abdominal organs; and the results have been surprisingly improved.

The administration of a generalized, instead of a local treatment, seems to be indicated also because such a treatment is more apt to promote processes leading to tumor immunity. It is a matter of speculation whether or not such a conception of the problem is sufficient to account for the superior results obtained by the generalized method of treatment, but it remains a matter of fact, that in a number of lymphomatous conditions, especially lymphosarcoma and pseudoleucemia, there is an apparent arrest or even cure, where at the time of the treatment there was such a generalization of the process that not all metastatic foci could be covered by irradiation.

As already shown in the first half of this paper, tumor immunity is connected with two factors: (*a*) antibody formation, and (*b*) stimulation of the lymphocytes.

In the lymphomas originating from the proliferation of the lymphocytic cell elements, it is probable that both factors are represented. Thus since the first effect of the roentgen rays is an almost immediate decrease in the size of the tumor irradiated, it is almost impossible to account for it by anything else but the direct destructive action of the rays on the tumor cells themselves. As Warthin and Case[37] have shown, the histo-organic products (chromatin) of the disintegrating cells are absorbed by the phagocytosis of the reticulo-endothelial cells of the lymph nodes and spleen and by the Kupffer cells of the liver, but the chemical substances liberated most probably remain in the blood, producing a stimulative effect on the antibody formation. During all this part of the process the lymphocytes are in their negative phase, consequently their part in increasing the resistant state of the body can be discounted. However, later they become of a great importance. Murphy and Morton[4] were the first to observe that the destruction of the lymphocytes by intensive radiation is followed in the regenerative process by a short period of overstimulation. Such an overstimulation was observed also in our cases (five to ten weeks following the treatment) when the lymphocytes in returning to their normal phase, for a few days, increase above the normal. As proven by Murphy and Morton's[12] experiments, such a lymphocytosis, as a rule, leads to the limitation of tumor grafts. It is possible, therefore, that in our cases tumor foci remaining unexposed to radiation were limited in their extension in a similar way by the action of the lymphocytosis.

The existence of tumor immunity, represented by both of the above factors, is supported also by the following clinical observations: In the radiation therapy of lymphatic leucemia one often sees tumefactions of the lymph nodes spontaneously disappear in a region far distant from the one exposed to radiation or when treating the spleen. Last year we[35] reported a case of generalized carcinomatosis, where all metastases spontaneously healed following a limited radiation therapy of a few metastatic processes of the pelvic bones. But merely the fact that in our cases of lymphosarcoma treated by roentgen therapy, such a large number of patients remained well, though at the time of the treatment there was such a generalization of the disease it was apparent that some tumor foci had to remain untreated, is a strong indication that some sort of immunization process must take place.

In the case of the proliferative processes of the reticulo-endothelial cell elements, such as Hodgkin's disease and Hodgkin's sarcoma, conditions are somewhat different. First the reduction in the size of the tumor masses following irradiation is much slower. As a result of this as compared with the lymphocytic tumors, there is much less cell destruction present in the time unit and there is a less degree of antibody formation. Here, due to severe disturbances of the hematopoietic system, the lymphocytic activity is also minimized. However this may be, it remains a matter of fact that Hodgkin's disease and Hodgkin's sarcoma when showing the same degree of advance as the lymphosarcomas mentioned above, though receiving the same amount of radiation, without exception rapidly progress towards their fatal end.

2. Intensive radiation should be used in treating the above lymphomatous conditions since destruction of the cells composing these tumors, as already shown, is

easily feasible. Because of the higher depth dose, penetrating rays will serve best the purpose. The quality of the roentgen rays used in our case is from 0.13 to 0.14 Å wave length.

The quantity of the radiation to be given over the individual lesions differs in the type of the tumor and depends mainly on the radiosensitiveness of the cells composing the tumor. Therefore in discussing the optimum dose for the various lymphoid cell proliferative processes, it is best to accommodate ourselves to the histological structure of each particular case. As a rule the lymphocytic cell proliferative processes because of the higher sensitivity of the lymphocytes, will need a 60 to 70 per cent skin unit dose, while in the processes where the reticulo-endothelial cell element dominates the histological structure, the dose is to be increased up to about 90 per cent S. U. D. The technique of exposure is discussed separately for each particular lesion.

1. *Simple Lymphoma.* Since the benign simple lymphoma is always the result of a chronic irritation mostly of bacterial origin, this condition is treated similarly to the chronic lymphadenitis, by using the same technique of exposure.

2. *Lymphatic Leucemia.*

(*a*) *Acute Lymphatic Leucemia.* We have treated by radiaton therapy 11 cases of acute lymphatic leucemia during the past four years. In all cases, though a reduction in the number of circulating lymphocytes was reached, and also a disappearance of the enlargements of the lymph nodes (Figs. 7 and 8) and a reduction in the size of the spleen was obtained, the usual course of the disease remained uninfluenced by the irradiaton and all patients died within a few months following the treatment. In 2 other cases the acute lymphatic leucemia was transformed into the chronic type, and thus the duration of the disease prolonged. It is probable, however, that in these 2 cases the condition of chronic lymphatic leucemia had existed from the beginning and the acute state as observed at the time of the examination was only an exacerbation of the chronic form. Both patients are still under treatment, and have been for a period of over one year.

Fig. 7. Enlargement of inguinal lymph nodes in acute lymphatic leucemia.

Fig. 8. Same as Figure 7. Ten days after roentgen treatment. The enlargement of the lymph nodes has disappeared.

Since in none of the cases of acute lymphatic leucemia treated by roentgen therapy was there any evidence of improvement, no matter what technique of exposure was used, no detailed description of any of the cases treated will be attempted.

(*b*) *Chronic Lymphatic Leucemia.* More successful is the radiation therapy in the chronic form of lymphatic leucemia. In all instances an immediate relief from the

distressing symptoms is brought about, and in a great many cases life is prolonged for a considerable period.

In establishing the best method of irradiation in chronic lymphatic leucemia, one has to take into consideration the following two factors:

(1) Chronic lymphatic leucemia is a lesion of the hematopoietic system and from the earliest stages there is involvement of the bone marrow. There has been considerable discussion during the past two decades with regard to the nature of chronic lymphatic leucemia. In another place we[39] exposed in detail the different views advanced and arrived at the conclusion that chronic lymphatic leucemia pathologically represents all the signs of a neoplastic transformation. From our observation on 3 cases of lymphosarcoma, which in their terminal stage transformed into lymphatic leucemia, we further expressed the opinion that chronic lymphatic leucemia is very closely related to lymphosarcoma. From the point of view of radiation therapy this means that a similar exposure to that of lymphosarcoma is to be applied also to chronic lymphatic leucemia. Furthermore, since the bone marrow becomes involved from the earliest stages, radiation therapy has to be applied in the first instance to these tissues (by exposing all long bones). In the second place, our attention is to be paid to the possibility of heterotopic deposits to other tissues (such as liver, kidney, etc.) and to the generalized lymphatic tumefactions.

(2) The irradiation of the spleen is of great importance in the treatment of chronic lymphatic leucemia. It is a matter of long observation, that the irradiation of the spleen with small fractional doses of "superficial" roentgen rays leads to considerable decrease in the number of the circulating lymphocytes. The exact action of the roentgen rays in producing such a condition is not definitely known. Since the spleen early becomes in the majority of cases of chronic lymphatic leucemia the seat of a process similar to that found in the bone marrow or the lymph nodes, it might be that the administration of small doses of roentgen rays, especially if done at frequent intervals, produces a direct destructive action on the highly radiosensitive lymphocytes. But the fact that the administration of the same doses of roentgen rays over lymphatic proliferations in other locations, e.g., in the lymph nodes of the neck, fails to produce a similar rate of reduction in the number of the circulating lymphocytes, indicates that some other factors must also be present. From the classical experiments of Pfeiffer and Marx or those of Morris and Bullock, we now know that the removal of the spleen renders animals more susceptible to experimental infections. It is possible that the spleen also possesses a similar protective action in the case of chronic lymphatic leucemia, and that the administration of small doses of roentgen rays produces a stimulative effect on this protective action. That such may be the case is brought out also by our following clinical observation: A splenectomy was performed in a very early case of a chronic lymphatic leucemia. Though there was a very good general condition of the patient before the operation, the circulating lymphocytes contrary to what was expected, started to increase so rapidly in number following the splenectomy that within two weeks the patient had all the signs of a severe progressive lymphatic leucemia. Soon secondary infections, such as sinus infection, mastoiditis and acute arthritis, aggravated the condition. At this time radiation therapy was instituted, however with little change of the severe general condition, so that the patient expired soon afterward. The unusually rapid progress of the lymphatic leucemia following splenectomy, together with the appearance of numerous secondary infections, indicate in our mind that the removal of the spleen brought about in this case a rapid collapse of the defense mechanism of the body.

Taking into consideration the two above factors, the following is our procedure in treating a case of chronic lymphatic leucemia.

First, stimulative irradiation—if we may call it so—is given over the spleen. Soft roentgen rays of 0.26 to 0.28 A (obtained by 80 to 135 kv. with 4 to 5 mm. Al as filter) are used, a single dose of 70 to 80

per cent S.U.D. on the skin (covering the area of the spleen) being given at the time. The treatment is repeated at six to eight days. As a rule, a slow decrease in the number of the circulating lymphocytes with gradual improvement in the general condition of the patient is produced soon after the first few irradiations.

Six to eight weeks later, when usually no or only very slight further reduction in the number of the lymphocytes can be obtained, a destructive irradiation over the long bones, the entire lymphatic system and the abdominal organs, is instituted. This consists in the administration of a 40 to 50 per cent S. U. D. dose over the pathological regions, by using hard rays of 0.13 to 0.15 A wave length. A most careful observation of the patient with daily blood count controls during this treatment is necessary. Often there is such a rapid destruction of the lymphocytes that their number after a few irradiations drops to zero, producing a severe disturbance in the balance of the blood metabolism, often leading to fatal results. If such a condition is in sight, treatment has to be interrupted, until the balance of the blood is reestablished. As a rule, we divide the treatment into two parts: first, we expose the long bones and part of the lymphatic system, and about four to six weeks later if the blood condition warrants, we continue the treatment with the exposure of the rest of the lymphatic system and of the abdominal organs. Only one single area is exposed in one day, and sometimes a period of two to three days is allowed between the exposures. Each series of treatment consists of seven to ten irradiations. During the entire treatment the patient is hospitalized.

As a rule there is a beginning reduction in the number of the lymphocytes within a few hours following the first exposure to intensive radiation. From this moment the decrease remains directly proportional to the dose and extent of the irradiation. There is no inconvenience, if the number of lymphocytes goes below the normal, even as low as 500, since within eight to ten weeks a complete regeneration follows. If the normal balance of the lymphocytes is once re-established, no further radiation is given. However the patient is kept under strict surveillance (by weekly or bimonthly blood controls) and as soon as there is a tendency to a relative or absolute increase in the number of the lymphocytes, the stimulative irradiation over the spleen is repeated. Usually a few exposures will suffice to reestablish the normal blood picture. By such a method the patient can be kept comfortable and able to perform his work for a period of years (Table 1). In the majority of cases, however, sooner or later a severe anemia develops which unfortunately cannot be influenced by further treatment, and the patients die. The anemia seems to be in direct proportion with the severity of the involvement of the bone marrow at the time of the treatment. It is peculiar, however, that in a great many cases the number of the lymphocytes in the blood remains normal or only slightly increased until death. The severe anemia seems to form the immediate cause of death.

Case VI. O. T. H., aged forty-seven, female, white.

History of Present Illness: In the first part of 1922 patient started to develop signs of dizziness, vertigo and general weakness. She did not pay much attention to these symptoms, but later severe leucorrhea developed. Patient also became intensely pale. In September, 1922, she noticed rapid enlargement of practically all the lymph nodes; there was distention of the abdomen and swelling of the feet. At this time the patient was examined in several hospitals and diagnosis of far advanced chronic lymphatic leucemia was made. Arsenic and rest treatment was prescribed. Finally, in December, 1922, she was referred for radiation therapy.

Physical Examination: 12–8–22. Patient very pale. There is puffy edematous appearance of the skin; swelling of the face and ankles. There is enlargement of practically all the lymph nodes, the enlargement being from 2 to 6 cm. in diameter. Abdomen swollen, evidence of slight ascites, spleen enlarged about three times its original size. There is very pronounced leucorrhea. Vaginal examination shows lymphomatous infiltration of the upper portion of the vagina and lower cervix. General condition of patient very poor. Not able to walk. Urine examination shows marked albuminuria. Wassermann reaction negative.

Blood Count. R. B. C. 3,850,000; W. B. C. 920,000; P. less than 1 per cent; S. L. 95 per cent; L. L. 3 per cent; Hgl. 60 per cent.

Diagnosis. Far advanced chronic lymphatic leucemia (Fig. 9).

Treatment. First, stimulative irradiation

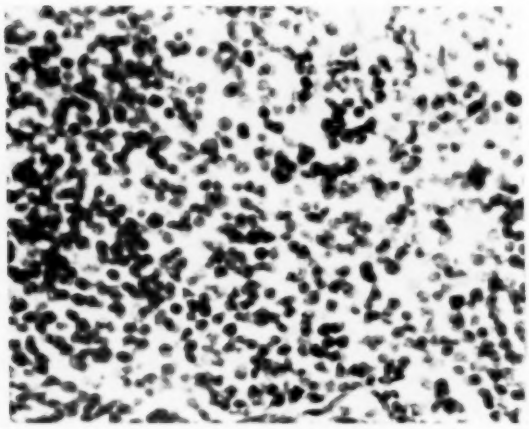

FIG. 9. Lymph node in chronic lymphatic leucemia (high power). Note diffuse overgrowth of lymphocytes.

over the spleen was given at weekly intervals. At the same time radium was applied over the infiltration of the vagina and cervix. Six to eight weeks later intensive radiation over the entire lymphatic system, long bones and abdominal organs, divided into two series of treatments, was given.

Technique of Exposure. 12-9-22. 55 mg. radium screened by 1 mm. brass and 1 cm. hard rubber, placed in the cervix for a period of twelve hours (50 per cent S. U. D.).

12-20-22: One area of superficial irradiation over spleen. Quality of roentgen rays: 0.24 A wave length (100 kv., 4 mm. Al as filter). Dose 80 per cent S. U. D. on the surface of the skin. (4 ma., 23 cm. skin target distance, 5 min., 20 ma-min).

This superficial irradiation was repeated at weekly intervals until 2-5-23 when the intensive radiation was started.

2-5-23: One area over both legs anteriorly, field 20 × 30 cm.

2-7-23: One area over lower third of both femora, field 20 × 30 cm.

2-8-23: One area over the upper femora, field 20 × 30 cm.

2-10-23: One area over both inguinal regions, field 20 × 20 cm.

At this time the number of the lymphocytes had decreased to below 2,000, and consequently the treatment was interrupted for a period of a month.

3-5-23: One area over the lumbar region and pelvis, field 20 × 30 cm.

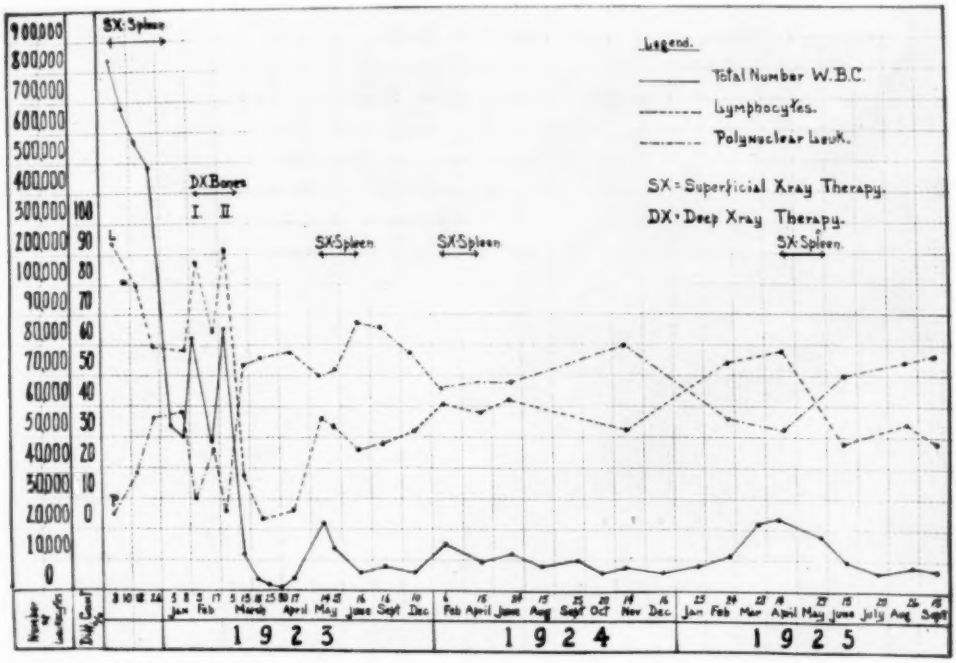

Table 1. Curve of the total white blood cells, as well as of the relative proportion between the polymorphonuclear leucocytes (P) and the lymphocytes (L) in chronic lymphatic leucemia, showing effect of radiation therapy. The treatment extended for a period of more than three years.

3–6–23: One area over abdomen anteriorly, field 20 × 30 cm.

3–7–23: One area over both cubital regions, field 10 × 10 cm.

3–7–23: One area over both submaxillary, cervical, supra- and infraclavicular regions, field 20 × 20 cm.

3–8–23: One area over both axillae, the ribs being also exposed, field 30 × 20 cm.

3–10–23: One area over the thoracic and cervical spine, field 15 × 35 cm.

Quality of the intensive roentgen rays: 0.137 Å wave length (200 kv., 1 mm. Cu plus 1 mm. Al).

Air cooled tube, 250 ma-min. (62½ min.) for the large fields, and 300 ma-min. (75 min.) for the small fields, skin target distance 50 cm. This makes 50 per cent S. U. D. surface dose.

There was quite a reaction following this intensive radiation lasting for a period of four to six weeks. After the disappearance of the reaction, the condition of the patient rapidly returned to normal and a re-examination May 30, 1923, showed her practically symptomless. From this moment the patient only occasionally received superficial irradiation over the spleen as shown in Table 1. Her condition remained practically normal for a period of over three years. In 1926 she developed signs of a progressive anemia and died on May 10, 1926.

3. *Pseudoleucemia.*

Pseudoleucemia is considered by a great number of authors as identical with chronic lymphatic leucemia except for the negative blood picture. Pathologically the condition is no doubt similar to lymphatic leucemia. Thus there is a generalized tumefaction of the lymph nodes, histologically consisting of a proliferation of the lymphocytic cell elements (Fig. 10), such as observed in lymphatic leucemia, but there is no discharge of the lymphocytes into the blood stream and this forms pathologically the main distinction between the two processes.

There is another point in which pseudoleucemia differs from lymphatic leucemia and which we think from the point of view of radiation therapy to be even more important than the blood condition: This is the very exceptional involvement of the bone marrow in pseudoleucemia. Although Senator[10] and v. Domarus[11] described under the name of medullary pseudoleucemia a primary involvement of the bone marrow, Ewing[12] considers the existence of such a condition as very doubtful. Of course, in the later stages of the disease pseudoleucemia might extend to the bone marrow in a similar way as we[39] have described for lymphosarcoma. In such a case lymphocytes may be discharged into the blood and thus the appearance of the transformation of the pseudoleucemia into a typical lymphatic leucemia might prevail.

Because of the lack of bone marrow

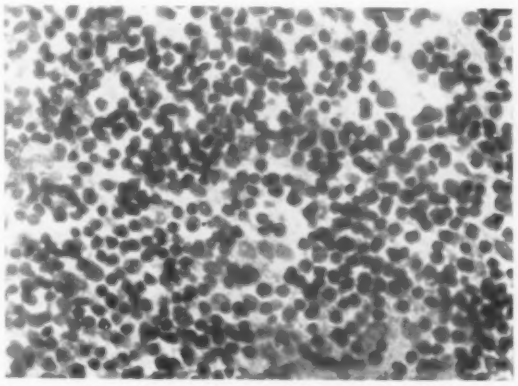

Fig. 10. Lymph node in pseudoleucemia (high power). Note identity of cells with those in chronic lymphatic leucemia.

involvement anemia, as a rule, is less pronounced and consequently the prognosis following radiation therapy is more favorable in pseudoleucemia than in lymphatic leucemia. *Restitutio ad integrum* often results and patients remain well for long periods.

The close relationship, if not identity, of pseudoleucemia with lymphatic leucemia, gives indication for the use of the same method of treatment. However, because of the negative blood findings, the stimulative irradiation over the spleen can be omitted and the treatment started immediately with the destructive radiation over the lymphatic system and abdominal organs. Because of the rare bone marrow involvement in pseudoleucemia the long bones are not exposed to radiation.

The dose is similar to that administered in chronic lymphatic leucemia, that is from 40 to 50 per cent S. U. D. Hard rays of 0.13 to 0.15 Å wave length are of advantage. During the entire treatment period the condition of the blood is controlled by means of daily blood counts. It is, however,

an exceptional occurrence that treatment has to be interrupted because of the very rapid decrease in the number of the lymphocytes as is so often the case in chronic lymphatic leucemia.

The tumefactions in pseudoleucemia rapidly disappear following radiation therapy, so that about ten days following the treatment practically all pathological lesions have disappeared.

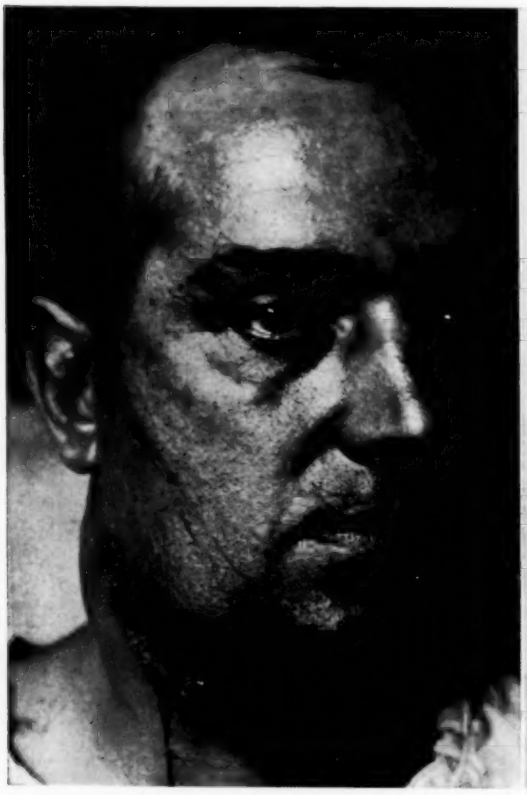

FIG. 11. Lymphosarcoma. Primary in the lymph nodes of the neck.

FIG. 12. Same as Figure 11. Ten days following roentgen therapy. The enlargement of the lymph nodes has disappeared.

CASE VII. W. D., aged fifty-nine, female, white.

History of Present Illness. In January, 1924, patient for the first time noticed a slight soreness in the right groin. The discomfort was increasing so that about a month later she could hardly sit or lie in a comfortable position. In March, 1924, she noticed a slight enlargement of the lymph nodes of the neck on the right side. There was no pain nor tenderness associated with this enlargement, however. In April, 1924, she noticed that the swelling had extended to the lymph nodes in the suboccipital and both axillary regions. She also complained of gradual weakness.

Physical Examination: 5-8-24. Very nervous patient, of a rather pale color. There is enlargement of practically all the lymph nodes, from 1 to 3 cm. in diameter in the suboccipital and preauricular regions; from 1 to 8 cm. in diameter in the submaxillary, cervical, supraclavicular and axillary regions; and from 5 to 15 cm. in diameter in the right groin. The lymph nodes in the left groin are but slightly enlarged. No tumors palpable within the abdomen. Liver and spleen of normal size. Stereoscopic plates of the chest are negative for evidence of enlargement of the mediastinal lymph nodes.

Urine examination negative. Wassermann negative. Blood pressure 154/108.

Blood Count. R. B. C. 4,180,000; W. B. C. 6,000; P. 76 per cent; S. L. 19 per cent; L. L. 2 per cent; Eo. 2 per cent; Mo. 1 per cent; Hgl. 75 per cent.

General condition fair. Slight loss of weight.

5-5-24: A lymph node from the neck was removed for microscopic examination.

Microscopic Diagnosis (Dr. P. F. Morse). Aleucemic leucemia with eosinophilia. An atypical form of lymphoblastoma which probably should be classified with either lymphosarcoma or with aleucemic leucemia (Fig. 10).

Treatment: Intensive radiation: 40 to 50 per cent S. U. D. over the entire lymphatic system and abdominal organs.

Quality of roentgen rays: 0.137 A wave length (200 kv., 1 mm. Cu plus 1 mm. Al as filter).

Technique of Exposure:

5-8-24: One area over both inguinal regions, field 20 × 20 cm.

5-9-24: One area over pelvis posteriorly, field 20 × 20 cm.

5-11-24: One area over both popliteal regions, field 20 × 20 cm.

5-12-24: One area over left preauricular, suboccipital, submaxillary, cervical, supra- and infraclavicular regions, field 20 × 30 cm. (thyroid gland and larynx well protected).

5-13-24: One area over left axilla, field 10 × 15 cm.

5-14-24: One area over right axilla, field 10 × 15 cm.

5-16-24: One area over abdomen posteriorly, field 20 × 20 cm.

5-17-24: One area over abdomen, right anterior oblique, field 20 × 20 cm.

5-18-24: One area over abdomen, left anterior oblique, field 20 × 20 cm.

5-19-24: One area over right preauricular, suboccipital, submaxillary, cervical, supra- and infraclavicular regions, field 20 × 30 cm. (larynx and thyroid gland protected).

5-20-24: One area over mediastinum posteriorly, field 10 × 15 cm.

5-21-24: One area over mediastinum anteriorly, field 10 × 15 cm.

A 60 per cent S. U. D. surface dose for the large fields, and 70 per cent S. U. D. for the smaller fields, was given over the above areas. The mediastinal lymph nodes were crossfired through two, and the abdominal lymph nodes through three fields. Air cooled tube, 4 ma. 300 ma-min. (75 min.) for the large fields, and 350 ma-min. (88 min.) for the small fields, skin target distance 50 cm.

There was a marked reaction following the treatment, lasting for a period of two to three weeks. About ten days following the treatment, all enlargements of the lymph nodes disappeared. Patient remained well until July, 1925, when she developed a rapidly progressive anemia and died.

4. *Lymphosarcoma.*

Lymphosarcoma is the result of the proliferation of atypical lymphocytes (Fig. 15). While the tumefactions of lymphatic leucemia and pseudoleucemia show a great respect towards neighboring tissues, lymphosarcoma soon destroys the capsule of the lymph node where it originates, and invades all tissues surrounding the primary focus. This local destructive character, together with the formation of early metastases, places lymphosarcoma among the clinically most malignant neoplasms.

According to the extent of the systemic invasion, pathologists prefer to classify lymphosarcoma into the (*a*) localized, and (*b*) diffuse type. Indeed some forms of lymphosarcoma have a great tendency to produce local tumor manifestations with invasion and destruction of the neighboring tissues, while others from the beginning appear in the form of multiple tumefactions, such as observed in lymphatic leucemia or pseudoleucemia. This distinction into two groups, however, remains of only pathologic interest.

From our standpoint, all lymphosarcomata have to be considered from the beginning as virtually generalized. It is a fortunate thing, however, that, as already shown by Kundrat[13] in 1893, by reason of the lymphatic permeation, the generalization remains confined to the lymphatic system and a few abdominal organs, such as intestinal mucosa, serous membranes, spleen, liver, etc., for quite a long period, and only in the terminal stages of the disease is there an extension by means of the invasion of the blood stream, also to other systems and tissues of the body. Because of this reason and also because of the already mentioned immunization process, lymphosarcoma, when treated by means of roentgen rays, can be arrested in a large number of cases by exposing, in addition to the primary lesion, the lymphatic system and abdominal organs to radiation.

As a rule, a dose of 70 per cent S. U. D. is administered over the manifest lesions, as well as over the entire lymphatic system and the abdominal organs. There is a pronounced reaction following such an intensive irradiation, often manifesting itself in severe intoxication, with high fever, lasting for a period of three to four days. The reaction is probably due to the

great amount of cell products liberated into the blood by the disintegrating tumor cells. All tumors, even of the largest size, disappear within ten days following the

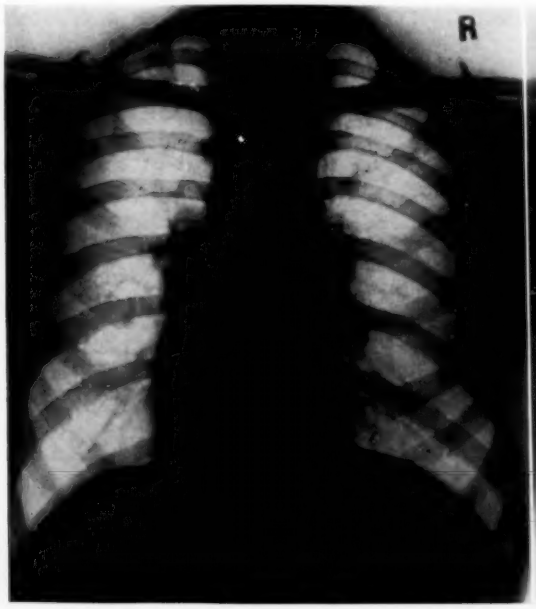

FIG. 13. Same case as in Figure 11. Metastasis of the lymphosarcoma to the mediastinal lymph nodes.

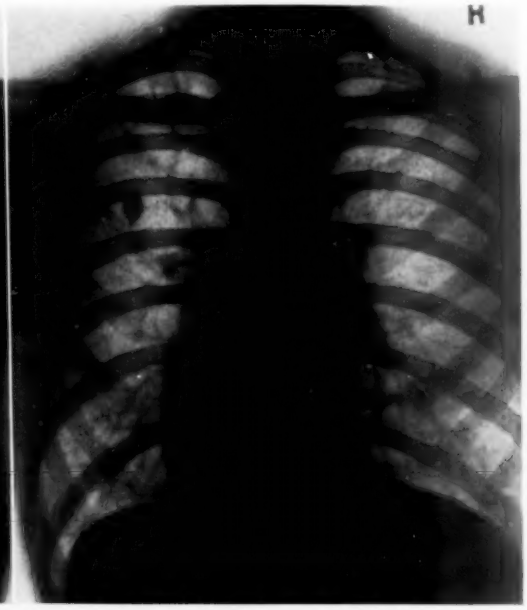

FIG. 14. Same as Figure 11 ten days following roentgen treatment. The enlargements of the lymph nodes have disappeared.

treatment. However, a re-irradiation of the manifest lesions within two to three months is advisable. Since an extension of the disease to other systems or tissues not exposed to radiation is possible, a careful observation of the patient for several years is necessary. In all our cases, where there was further extension of the disease (see cases published under reference 39) this occurred within a few months following the first irradiation. Further irradiation remained here without avail.

CASE VIII. P. H. B., aged thirty-six, male, white.

History of Present Illness: In June, 1923, patient developed a swelling on the right side of the neck, which gradually increased in size. He had received medical treatment for a period of several months while the lesion continued to enlarge. In October, 1923, a lymph node was removed from the neck and microscopic examination showed lymphosarcoma (Fig. 15). At this time the patient was referred for radiation therapy.

Physical Examination: 10–15–23. There is a large swelling of the right side of the neck (Fig. 11). There is also enlargement of the supraclavicular lymph nodes from 1 to 3 cm. in diameter. There is no enlargement on the opposite side. No evidence of enlargement of any of the other lymph nodes. No masses palpable within the abdomen. Liver and spleen

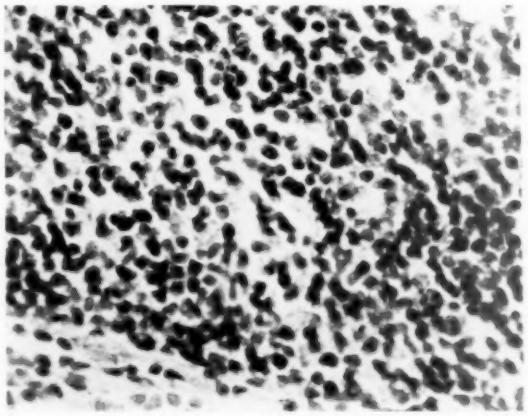

FIG. 15. Lymphosarcoma in lymph node (high power). Marked proliferation of atypical lymphocytes. Note involvement of the capsule of the lymph node by the invading lymphocytes.

of normal size. Stereoscopic plates of the chest show evidence of a slight enlargement of the mediastinal lymph nodes (Fig. 13).

Urine examination negative. Wassermann negative. Blood count: R. B. C. 3,680,000; W. B. C. 5,000; P. 84 per cent; S. L. 14 per cent L. L. 2 per cent; Hgl. 75 per cent. General condition good. No loss of weight.

Diagnosis: Lymphosarcoma of the cervical lymph nodes.

Treatment: Intensive radiation; 70 per cent S. U. D. over the entire lymphatic system, mediastinum and abdominal organs.

Quality of roentgen rays: 0.137 A wave length (200 kv., 1 mm. Cu plus 1 mm. Al).

Technique of Exposure:

10–15–23: One area over submaxillary, cervical, supra- and infraclavicular regions, field 20 × 30 cm. (larynx and thyroid gland protected).

10–16–23: One area over each axilla, field 10 × 15 cm.

10–18–23: One area over both inguinal regions, field 20 × 20 cm.

10–19–23: One area over the mediastinum anteriorly and one area posteriorly, field 10 × 15 cm.

10–21–23: One area over abdomen posteriorly, field 20 × 30 cm.

10–22–23: One area over abdomen, right anterior oblique, and one area left anterior oblique, field 20 × 20 cm.

An 80 per cent S. U. D. surface dose for the large fields, and a 90 per cent S. U. D. for the smaller fields, was given over the above areas. The mediastinal lymph nodes were crossfired through two fields, and the abdominal lymph nodes through three fields.

Air cooled tube, 4 ma., 400 ma-min. (100 min.) for the large fields, and 450 ma-min. ($112\frac{1}{2}$ min.) for the small fields, skin target distance 50 cm.

There was very little reaction following the treatment. There was no fever present. Within ten days the enlargement of the lymph nodes in the neck (Fig. 12) as well as of those in the mediastinum (Fig. 14) entirely disappeared.

When last heard of (June, 1925) the condition of this patient was satisfactory.

5. *Large Round Cell Sarcoma or Reticulum Cell Sarcoma*

In treating lymphosarcomata by roentgen therapy, we repeatedly observed that some of them, though clinically and pathologically diagnosed as such, do not show the characteristic response of lymphosarcoma towards radiation. Thus while the typical small round cell lymphosarcomas as a rule entirely disappear within ten days following irradiation, these tumors are longer in disappearing and also show a greater tendency towards recurrence. In rechecking the histological findings in such cases, we almost invariably found that the cells forming the tumors were of the large type. Ewing[12] was the first to call attention to the fact that lymphosarcoma may be either of the small round cell variety originating from the proliferation of the lymphocytes (malignant lymphocytoma) or of the large round cell type originating from the reticulum cells of the germ centers of follicles and pulp cords (reticulum cell sarcoma or large round cell lymphosarcoma). We found that our tumors represent such reticulum cell sarcomas, their radiosensitivity being more similar to that of Hodgkin's granuloma. The following is such a case:

Case IX. C. H. M., aged thirty-seven, male, white.

History of Present Illness. In the summer of 1922 the patient developed a sinus trouble. He received conservative treatment for a period of about six months, the diagnosis being chronic sinus infection. In September, 1923, the patient for the first time noticed an enlargement of a lymph node on the left side of the neck. This enlargement was progressive and soon the lymph nodes on the other side of the neck also became swollen. On December 27, 1923, a lymph node from the neck was removed for microscopic examination. This was diagnosed as lymphosarcoma and the patient was referred for radiation therapy.

Physical Examination. 12–20–23. There is a marked enlargement of the submaxillary lymph nodes on both sides, more pronounced on the left side, from 1 to 10 cm. in diameter (Fig. 16). There is no enlargement of other lymph nodes; no masses palpable within the abdomen. The roentgen examination of the chest shows no enlargement of the mediastinal lymph nodes. Patient had considerable difficulty in breathing and examination of the nasopharynx reveals a large tumor mass protruding from the pharyngeal wall and narrowing considerably the nasopharyngeal route.

Urine Examination negative. Wassermann reaction negative.

Blood Count. R. B. C. 4,000,000; W. B. C. 6,600; P. 76 per cent; S. L. 16 per cent; L. L. 4 per cent; Mo. 4 per cent; Hgl. 95 per cent.

General condition of patient good. No loss of weight.

Diagnosis. Based on the microscopic specimen at first diagnosis of lymphosarcoma, prob-

ably originating from the pharynx was made, however, since the mass on the neck refused to disappear within ten days following the S. U. D., with but little effect. The patient's condition was rapidly deteriorating and he died on July 24, 1924.

FIG. 16. Large round cell lymphosarcoma or reticulum cell sarcoma of the lymph nodes of the neck; primary in nasopharyngeal tissues.

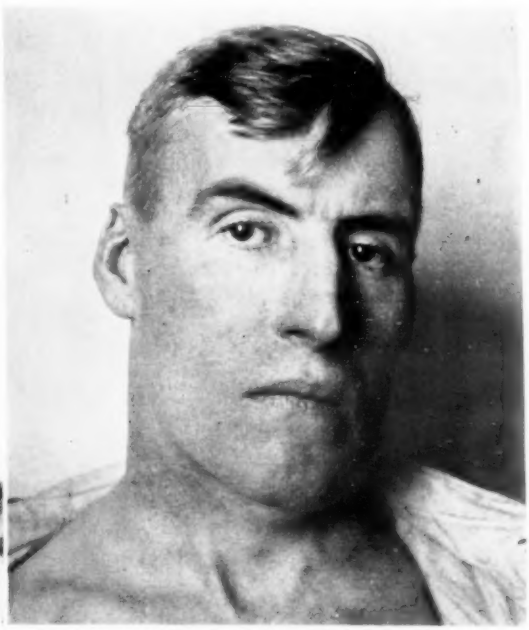

FIG. 17. Same as Figure 16, three weeks following roentgen therapy. There is still slight enlargement of the lymph nodes. (This forms a criterion of differentiation from small round cell lymphosarcoma or lymphocytoma.)

treatment, as is the case in typical lymphosarcoma, the microscopic section was rechecked and diagnosis of large round cell sarcoma was made (Fig. 18).

Treatment: Intensive radiation.

Since a diagnosis of lymphosarcoma was first made, 70 per cent S. U. D. was given over the entire lymphatic system, mediastinum and abdominal lymph nodes. (When the diagnosis of large round cell sarcoma is made at the beginning a dose of 90 per cent S. U. D. is given.) The primary lesion in the pharynx was also included in the irradiation. The technique of exposure was the same as in Case VIII.

The tumors had reduced to only about half of the original size upon re-examination ten days following the treatment; they did not entirely disappear until about four weeks following the treatment and even then only for a short period (Fig. 17). At a re-examination 2-18-24 the lymph nodes were again enlarged from 1 to 6 cm. in diameter. The treatment was repeated at this time over the enlarged lymph nodes, the dose having been increased to 90 per cent

6. Leucosarcoma.

This lesion of the lymphoid tissues is very rare. In another article[39] we have reviewed the literature with regard to its relationship to lymphosarcoma, and from

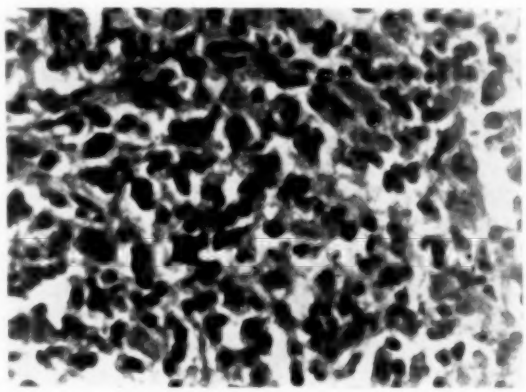

FIG. 18. Large round cell lymphosarcoma or reticulum cell sarcoma (high power). Note the difference in the cellular structure, as compared with Figure 15.

our own observations that a condition similar to leucosarcoma arises whenever the lymphosarcoma extends to the bone marrow, we arrived at the conclusion that leucosarcoma represents a lymphosarcoma which by involving the bone marrow produces the blood picture of lymphatic leucemia. Since such a condition as a rule represents the terminal stage of lymphosarcoma, radiation therapy is of but little effect.

7. *Hodgkin's Disease.*

A great deal of discussion has arisen during the past two decades with regard to the nature of Hodgkin's disease and its relationship to the above mentioned lesions of the lymphoid tissues. There was and still is a great tendency to deny the distinct entity of Hodgkin's disease. It seems, however, that the introduction of roentgenological criteria would help to disprove such a conception of the problem. Thus there is the different radiosensitivity of Hodgkin's disease (and Hodgkin's sarcoma) as already mentioned in the first part of this paper, as compared to the rest of the lymphoid processes. But there is a still more important sign, which in our minds definitely separates Hodgkin's disease (and Hodgkin's sarcoma) from other lymphoid tumors: this is that Hodgkin's disease (and Hodgkin's sarcoma) never shows transformation into anything like a typical monophasic lymphatic proliferative process. In another article[39] we showed that lymphosarcoma, if life is sufficiently prolonged—by means of roentgen therapy—so that the lesion may extend to the bone marrow, frequently transforms into lymphatic leucemia. We have not observed this to be true for Hodgkin's disease, though extension of Hodgkin's disease to the bone marrow is a more common occurrence than in lymphosarcoma. Ziegler[11] who reviewed the literature of Hodgkin's disease up to 1911, reports, for example, bone marrow involvement in 30 to 40 per cent of the cases, while Symmers[35] thinks that the bone marrow is involved in 100 per cent. In our cases where radiation therapy prolonged life, there were signs that the bone marrow became involved in every case. However none of the cases developed the picture of lymphatic leucemia. Simonds,[34] in his review of Hodgkin's disease, makes mention of the personal communication of Dr. A. W. Crane according to which patients with Hodgkin's disease after being vigorously treated with roentgen rays, sometimes develop the blood picture of leucemia. Langley[46] describes similar occurrences; however, in his case the diagnosis of Hodgkin's disease was not entirely confirmed. In our experience such a transformation never occurs in the true form of Hodgkin's disease.

In studying the response of the different forms of Hodgkin's disease towards radiation, the histopathology of the process has to be made a fundamental criterium of the differentiation. The classification into clinical sub-varieties, although interesting from the pathological standpoint, has no bearing on the radiation response, except for the fact that localized manifestations are more apt to result in permanent cures, while a temporary improvement is all that can be expected in the generalized forms. The histological distinctions in the different phases of the disease are of somewhat more importance.

According to the cellular variations, we distinguish the following histopathological types in the development of Hodgkin's disease (Fabian,[47] Symmers[35] and Simonds[34]):

(1) Hyperplasia of the lymphocytic cell elements.

(2) Proliferation of the reticulo-endothelial cell elements; endothelial cells, epithelial cells, endothelial giant cells, reticular cells, fibroblasts and eosinophil cells.

(3) Fibrosis resulting from the very marked proliferation of the fibroblasts, later dense fibrous stroma and hyalinization.

The first condition, that of the hyperplasia of the lymphocytic cell elements, is observed only rarely. Even the earliest forms of Hodgkin's disease presenting for observation always show evidence of proliferation of other cell elements. Many pathologists therefore directly deny the primary importance of the lymphatic state, and consider, from the beginning, the proliferation of the reticulo-endothelial cell elements as the specific feature of the disease. In our collection one single case arrived

for observation which might be considered as a primary hyperplasia of a very early Hodgkin's disease. However, judging from the radiosensitivity of the lesion, the presence of other cell elements, less sensitive to radiation, has to be admitted. The following is a case:

CASE X. W. W., aged fourteen, male, white.

History of Present Illness: In January, 1923, patient for the first time observed slight enlargement of the lymph nodes of the left postauricular region. The enlargement continued very slowly, therefore the patient paid but little attention to it. In April, 1923, one of the lymph nodes was removed—by the house physician—for microscopic examination. The following was the report from the section: 4-3-23 (Dr. A. S. Warthin). "Hyperplasia with the structure of the glands still preserved; hyperplastic germ centers with lymphoid exhaustion; general increase of stroma; thickening of blood vessel walls and numerous atypical lymphoblasts. These suggest a possible early Hodgkin's. There are no eosinophiles, however, and the structure of the gland is so well preserved that the only possible diagnosis I can make is that of an atypical chronic lymphadenitis suggesting early Hodgkin's." At this time the patient was referred for radiation therapy.

Physical Examination 4-13-23. There is enlargement of the lymph nodes in the left postauricular region, from 1 to 2 cm. in diameter. There is also slight enlargement of the cervical and supraclavicular nodes on the same side. No enlargement of other lymph nodes. No masses palpable within the abdomen. Liver and spleen of normal size. Stereoscopic plates of the chest show increased root infiltration but no enlargement of the mediastinal lymph nodes. Blood count normal. Urine examination negative. General condition of patient good. No loss of weight.

Diagnosis: Early Hodgkin's disease; stage of lymphatic hyperplasia.

Treatment: Intensive radiation 90 per cent S. U. D. over the entire lymphatic system, mediastinum and abdominal organs.

Quality of roentgen rays: 0.142 Å wave length (205 kv., 1 mm. Cu plus 1 mm. Al as filters).

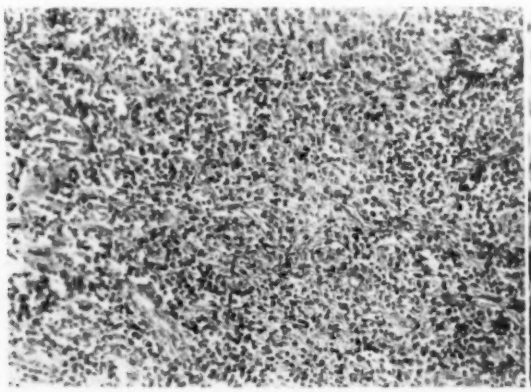

FIG. 19. Hodgkin's disease (low power). Diffuse proliferation of reticulo-endothelial cell elements; in places fibroblasts with beginning fibrosis.

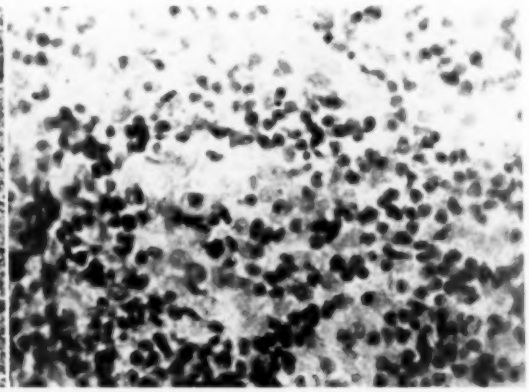

FIG. 20. Hodgkin's disease (high power). Diffuse proliferation of reticulo-endothelial cells.

Technique of Exposure: From 4-12-23 to 4-18-23 the lymphatic system, mediastinum and abdominal organs were exposed similar to Case VIII, except for the larger dose used.

A 90 per cent S. U. D. surface dose to the large fields, and a 100 per cent S. U. D. to the smaller fields was administered.

Air cooled tube, 4 ma., 450 ma-min. (112 min.) for the large fields, and 500 ma-min. (125 min.) for the small fields, skin target distance, 50 cm.

There was a severe reaction following this treatment lasting for several months. The enlarged lymph nodes slowly disappeared (much slower than would be the case in a lymphosarcoma of similar size). In 1923, 1924, and 1925 examination revealed a normal condition. Lesion apparently healed.

The majority of the cases of Hodgkin's disease arriving for radiation therapy are, however, not so favorable as the above case. Histologically as a rule they belong to the second or third stage of development: i.e., when the proliferation of the reticulo-endothelial cell elements and their derivatives (Figs. 19 and 20) dominate

the picture. There may be quantitative varieties in the proportion of the cells,

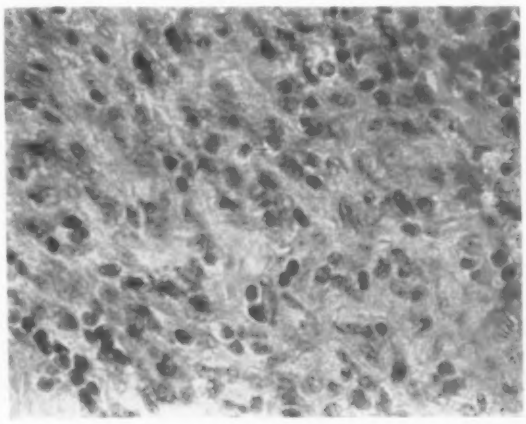

Fig. 21. Hodgkin's disease (high power). Diffuse proliferation of reticular cells.

sometimes the endothelial cells (Fig. 22), at other times the reticular cells (Fig. 21) being in prominence. Again at other times the fibroblasts resulting in marked fibrosis and hyalinization form the main feature

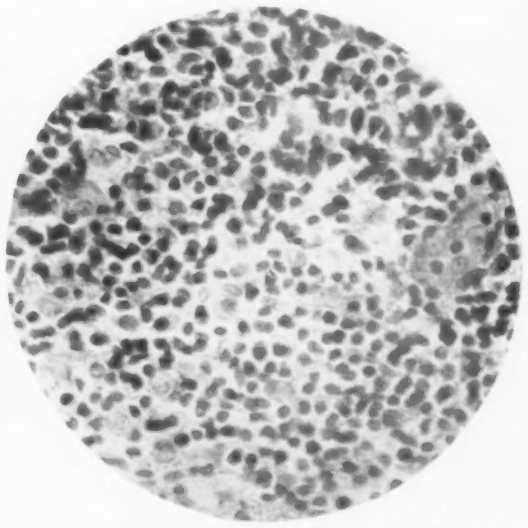

Fig. 22. Hodgkin's disease (high power). Diffuse proliferation of endothelial cells.

of the disease. The chances from the point of view of irradiation remain in all cases the same: If the process is localized to only one group of lymph nodes, the prognosis is better, but when there is extension to all of the lymph nodes and when there are heterotropic deposits in other organs and especially when there is a tendency towards marked fibrosis, the prognosis is unalterably severe.

Fig. 23. Hodgkin's disease. Enlargement of the mediastinal lymph nodes.

Fig. 24. Same as Figure 23, six weeks following roentgen treatment. The enlargement of the lymph nodes has disappeared.

When the lesion is localized and the

general condition of the patient is good, we use the intensive radiation as practised in Case x, but when the lesion is already generalized and especially when there is a severe anemia present, a light irradiation by fractional doses seems to appear of more practicability. A relief of the symptoms and the prolongation of life is often accomplished in such cases, but a definite cure belongs to the exceptional occurrences.

(Figs. 25 and 26) made to absorb. In cases of severe pruritus this can be stopped. However the anemia can only rarely and temporarily be improved.

MEDIASTINAL HODGKIN'S DISEASE

There is one form of Hodgkin's disease which, from the point of view of radiation therapy, has to be considered separately. This is the mediastinal Hodgkin's, forming bulky tumors within the chest, which give

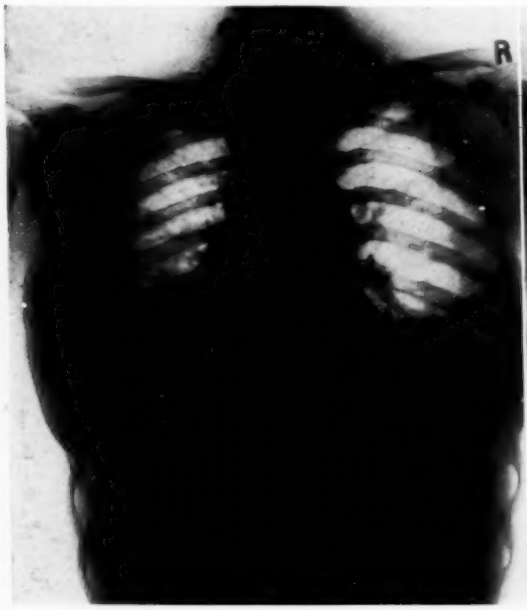

FIG. 25. Hodgkin's disease. Enlargement of the mediastinal lymph nodes and diffuse infiltration of the lower lobes of both lungs.

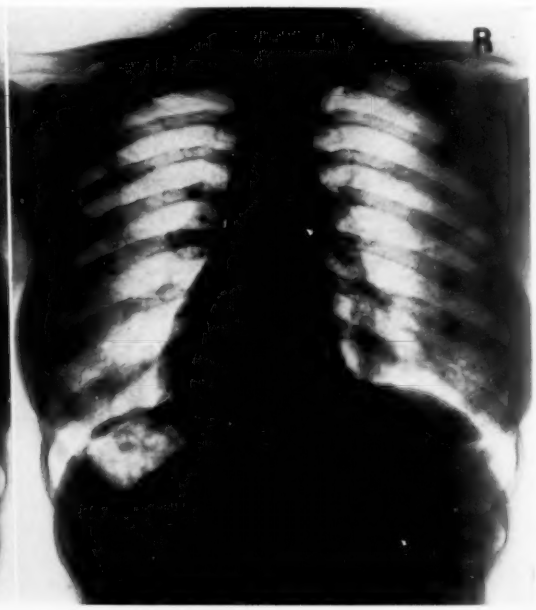

FIG. 26. Same as Figure 25, six weeks following roentgen treatment. The enlargement of the mediastinal lymph nodes, as well as the infiltration of the lungs, has disappeared.

The main symptom we can hope to relieve is the disappearance of fever. Vasiliu and Goia[18] showed that fever is present in 90 per cent of cases of Hodgkin's disease. In 20 per cent this is of the recurrent type; in 50 per cent of—what they call —the continuous undulant type, that is, the recurrent type, without entirely apyretic periods; in 20 per cent of the remittent or intermittent types, and only 10 per cent remain free of fever. Following radiation therapy the fever always disappears and patients remain comfortable for long periods.

Tumefactions can also be reduced in size (Figs. 23 and 24) and important infiltrations such as induration of the lungs

the appearance of a malignancy rather than that of a granuloma, and which have a tendency to remain localized for a longer period than occurs with the average typical Hodgkin's disease. Ewing[19] by examining the microscopic appearance of such mediastinal tumors, found that they often represent a sarcomatous condition (arising from the thymus). From the point of view of radiation therapy, they show the same rate of reduction in the size of the tumor following exposure to roentgen rays as the Hodgkin's granuloma, that is, at the end of ten days, in contradistinction to the true lymphosarcomas, they show a reduction to only about half of the original size

and only at the end of the sixth week will they have entirely disappeared.

The prognosis of mediastinal Hodgkin's disease following radiation therapy, because of the tendency of the tumor to remain localized to the mediastinum for a longer period, is much better than that of an average case of Hodgkin's granuloma.

The method of treatment is the same as the other cases of Hodgkin's disease. A dose of 90 per cent S. U. D. is given over the mediastinum (by the cross fire method with 3 to 5 ports of entry), as well as over the entire lymphatic system and the abdominal organs. In order to prevent fibrosis the lungs are well protected during the irradiation and a treatment over the mediastinum is not repeated unless there is evidence of recurrence and then not within three months.

The following is a case of mediastinal Hodgkin's disease.

FIG. 27. Mediastinal Hodgkin's disease.

FIG. 28. Same as Figure 27, ten days following roentgen treatment. The lesion has reduced to only about half the original size. This forms a criterion of differentiation from lymphosarcoma.

CASE XI. L. W. E., aged thirty-eight, male, white.

History of Present Illness. In February, 1923, the patient for the first time noticed a very persistent cough. There was no expectoration connected with the cough. In the summer of 1923 he started to become somewhat hoarse, the cough becoming somewhat more intensive. In November, 1923, he noticed a dyspnea, more pronounced on exertion. Later the dyspnea became so marked that he was unable to continue work. In January, 1924, he had considerable difficulty in breathing and could get comfortable only in a sitting position. At night he could not lie down. At times he became intensely blue. At this time he was referred by his family physician to our department for examination and treatment.

Physical Examination. Patient very dyspneic, has considerable difficulty in breathing. There is a slight edema of the neck, such as observed secondary to mediastinal pressure. The physical as well as the roentgenological examination of the chest shows a large mediastinal mass with marked pressure of the trachea and neighboring tissues (Fig. 27). There is no enlargement of any of the lymph nodes. No masses palpable within the abdomen. Spleen and liver of normal size.

Urine examination negative. Wassermann reaction negative.

Blood Count. R.B.C. 5,120,000; W. B. C. 11,300; P. 68 per cent; S.L. 27 per cent; L.L. 3 per cent; Eo. 2 per cent; Hgl. 90 per cent. General condition fair. No loss of weight.

The condition could not be exactly diagnosed at this time. A tentative diagnosis of mediastinal tumor, such as lymphosarcoma or mediastinal Hodgkin's, was made. However, since

following radiation therapy the mass did not entirely disappear at the end of ten days, the diagnosis of lymphosarcoma (or other related lymphocytic cell proliferative processes) was disregarded and that of mediastinal Hodgkin's sustained. This was further confirmed by the fact that six weeks following the treatment the mass had entirely disappeared.

Treatment: Intensive radiation over the mediastinum, entire lymphatic system and the abdominal organs: 90 per cent S. U. D. administered over the individual areas.

FIG. 29. Same as Figure 27, six weeks following roentgen treatment. Lesion has entirely disappeared.

Quality of roentgen rays: 0.137 A wave length (200 kv., 1 mm. Cu plus 1 mm. Al as filters).

Technique of Exposure. From 1–14–24 to 1–20–24 the mediastinum was crossfired through five ports of entry and the entire lymphatic system and abdominal organs were treated similar to Case VIII, except for the fact that a larger dose was given.

There was little reaction following the treatment, and within one week the patient, although against our advice, returned to work. The cough continued for a period of about two weeks, then ceased. The difficulty in breathing also disappeared. A re-examination of the chest ten days following the treatment showed the mediastinal mass reduced to about half of its original size (Fig. 28). Another examination six weeks following the treatment revealed that the mass had entirely disappeared (Fig. 29). General condition of the patient at this time very satisfactory.

5–12–24. Treatment over the mediastinum was repeated. However, at this time only two ports of entry were used, the dose being considerably reduced. The treatment also was extended to the lymphatic system and abdominal organs. There was little reaction following this series.

The patient's condition has remained normal since.

8. *Hodgkin's Sarcoma.*

Transformation of Hodgkin's disease into a sarcomatous condition was first described by Yamasaki[50] (2 cases) later by Coley[51] and Karsner[52]. Ewing[42] also found that in some instances the proliferation of the endothelial cells in Hodgkin's disease becomes so active that the cells finish by losing their endothelial character and transform into large round cells giving origin to a sarcomatous process called Hodgkin's sarcoma. In Ewing's opinion it is probable that many of the cases described in the literature as lymphosarcoma are of the Hodgkin's sarcoma variety.

We succeeded in studying such a case from the point of view of its response to irradiation. While the clinical appearance of the case observed was that of a typical Hodgkin's disease, the histological examination of a removed lymph node showed the presence of a sarcomatous process, with a combined cell activity characteristic of both Hodgkin's disease and the sarcomas. Roentgenologically the condition showed a degree of radiosensitivity which is common for Hodgkin's granuloma, probably due to the morphological preëminence of the endothelial cells and their transformed derivatives. It is absolutely certain that the process differs from lymphosarcoma or pseudoleucemia, for which it is taken by many, since the high radiosensitiveness of these lymphoid tumors never can be observed in Hodgkin's sarcoma.

The prognosis of Hodgkin's sarcoma, since it represents the terminal stage of Hodgkin's disease, is unfavorable. The method of treatment is the same as for Hodgkin's disease.

CASE XII. L. F., aged thirty, male, white.

History of Present Illness. In April, 1924, patient for the first time started to cough and

FIG. 30. Hodgkin's sarcoma. Enlargement of all submaxillary, cervical and supraclavicular lymph nodes.

FIG. 31. Same as Figure 30, six weeks following roentgen treatment. The enlargements of the lymph nodes have practically disappeared.

FIG. 32. Same case as in Figure 30. Enlargement of the mediastinal lymph nodes and infiltration of the lungs.

FIG. 33. Same as Figure 32, six weeks following roentgen treatment. The enlargement of the mediastinal lymph nodes and the infiltration of the lungs is considerably reduced in size.

was losing weight. It is probable, however, that his condition was of much earlier origin since, as patient states, he did not feel perfectly well for a period of something over a year. In September, 1924, the cough became very intensive and at this time he also started to feel short of breath. Because of the constant fever he felt very weak. He also noticed enlargement of the neck. Finally he went to Receiving Hospital where a lymph node was removed for microscopic examination and he was then transferred to Harper Hospital for radiation therapy.

The microscopic examination of the removed lymph node shows advanced polymorphonuclear celled sarcoma (Dr. P. F. Morse) (Figs. 34 and 35).

Diagnosis. Hodgkin's disease transformed into sarcoma.

Treatment. Intensive radiation 90 per cent S. U. D. over the mediastinum, involved lungs, as well as over the entire lymphatic system and abdominal organs.

Quality of Roentgen Rays. 0.137 Å wave length (200 kv., 1 mm. Cu plus 1 mm. Al as filters).

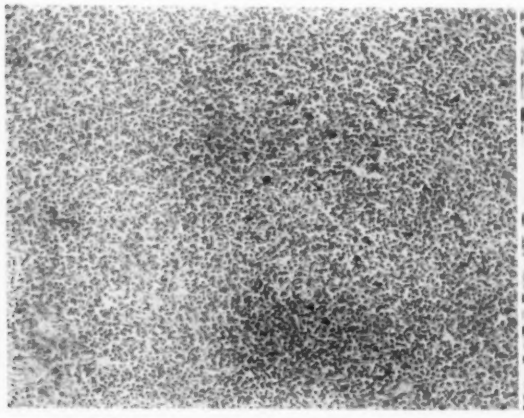

FIG. 34. Hodgkin's sarcoma (low power). Diffuse proliferation of cells showing sarcomatous character.

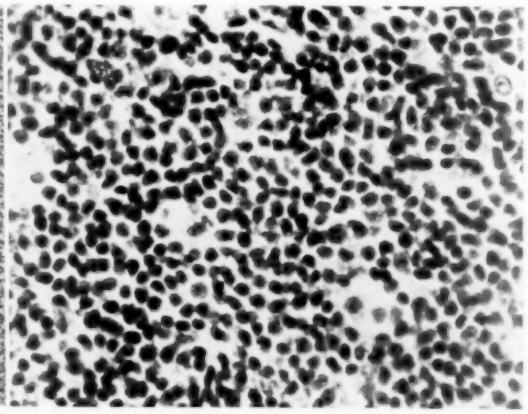

FIG. 35. Hodgkin's sarcoma (high power). Diffuse proliferation of the endothelial cells. In places the cells have lost entirely their endothelial character and transformed into large round cells. Compare with the typical endothelial cells in Hodgkin's disease (Fig. 22).

Physical Examination. Very pale, underweight patient; at times attacks of marked dyspnea; considerable difficulty in breathing. There is enlargement of practically all the lymph nodes, the enlargements being from 1 to 15 cm. in diameter (Fig. 30). Patient hoarse and can hardly talk. Laryngoscopic examination shows general edema and thickening of all of the laryngeal structures.

Physical and roentgenological examination of the chest shows evidence of a very wide upper mediastinal shadow with narrowing of the trachea. There is an extensive tumor-like involvement of the mediastinum and there is consolidation of the base of the upper lobe on the right side (Fig. 32). Abdomen enlarged, spleen palpable, about twice its original size. Liver slightly enlarged. No ascites. Small petechiae over the lower extremities.

Wassermann negative. Urine examination shows albuminuria.

Marked fever of the recurrent type (as high as 103°).

Blood Count. R. B. C. 4,350,000; W. B. C. 9,700; P. 82 per cent; S. L. 11 per cent; L. L. 5 per cent; Eo. 2 per cent; and Hgl. 80 per cent.

Technique of exposure same as in Case XI.

Following the roentgen therapy the enlargements of the lymph nodes practically disappeared (Fig. 31), and also the mediastinal and lung involvement considerably reduced in size (Fig. 33). However, the improvement was of only temporary duration. In December, 1924, the condition of the patient began to deteriorate rapidly and on December 27, 1924, patient expired.

BLOOD CHANGES PRODUCED BY THE DIFFERENT METHODS OF IRRADIATION

It is a question of paramount importance whether or not the different methods of irradiation such as advised for the treatment of the lesions of lymphoid tissues have an injurious effect on the normal hematopoietic system, and in case damage occurs whether or not this is of a permanent character or only of a transient duration.

A voluminous literature has been written during the past two decades on this subject. More recently Minot and Spurling,[38] by reviewing the entire literature and also from numerous observations of their own, evaluated the different blood effects due to irradiation. Since Minot and Spurling in their investigations covered the entire problem in a most excellent manner, it is unnecessary for us to enter into detailed reconsideration of these effects. However we should like to insist on some changes which arise from the more intensive radiation used in many of our cases.

As compared to the amount of radiation applied by Minot and Spurling, the doses administered in most of our cases exceeded several times their largest doses. This is especially true if we take into consideration the surface of the body exposed to radiation. Levin[24] for the first time observed, and this was brought out also by Minot and Spurling, that the blood changes produced depend mostly on the size of the surface of the body exposed to radiation. The same amount of roentgen rays will produce more severe changes if scattered over a larger surface of the body, than when concentrated in the form of the correspondingly larger dose over a smaller area. In several of our cases the radiation extended to almost half of the actual surface of the body.

The administration of such extensive irradiation of course results in blood changes which are more severe in character, though essentially the same, as the ones described by Minot and Spurling. Thus the leucopenia may be so pronounced that often not more than 500 (in one case only 50) white blood cells per cubic millimeter are counted (Table II). The lowest level as a rule is reached at the end of eight to ten days, and after a period of several days a slow regeneration begins. In some instances the normal number of the white cells is not reached until two to three months following the treatment. The lymphopenia, which is always more pronounced than the leucopenia, is in its regeneration often followed by a short period of over-stimulation. From the beginning of the fourth to the sixth week, there is also a reduction in the number of the red corpuscles lasting for a period of several months.

The knowledge of these blood changes is very important from the point of view of the post-irradiation care. The disturbed blood equilibrium with the depressed protective mechanism of the body often results in secondary infections, such as pneumonia, nephritis, arthritis, mastoiditis, etc., not infrequently with critical results. Therefore, a careful surveillance of the patient for a period of two to three

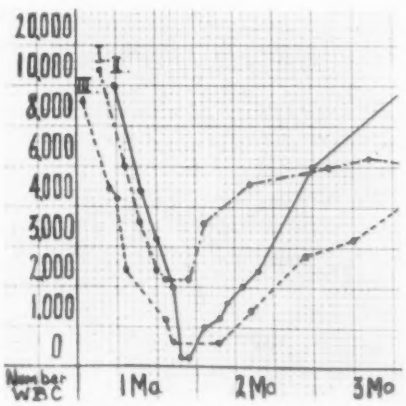

TABLE II. Curve of the total white blood count (3 cases) following intensive roentgen therapy. The pronounced leucopenia is the result of the radiation effect.

months following radiation therapy is more than necessary. Absolute rest, favorable climate, high calory diet, the avoidance of any contact with possible infection, cannot be sufficiently advocated. Because of the tendency towards anemia, blood stimulants are administered from the earliest possible moment.

By following the above regime we never observed undesirable complications in the post-irradiation period. However, 3 of our patients, who against our advice returned to work immediately following radiation therapy, developed severe pneumonias and other infections, two of them with fatal results.

STATISTICAL RESULTS OF RADIATION THERAPY

In examining the results obtained by radiation therapy in the different lesions having progressive enlargement of lymphoid tissues as their most important charac-

teristics, there is one thing which immediately strikes the observer: No benefit results from the collective consideration of these conditions under the general heading of lymphoblastoma or malignant lymphomas, as there is a tendency at the present time to do. Likewise, a distinct separation must be drawn between the old method of "superficial" radiation and the intensive radiation by means of penetrating rays, or the usually insufficiently applied radium treatment. Only by taking account of all these criteria can we arrive at a just appreciation of the value of the irradiation and its different methods of application.

In trying to compare the results obtained by intensive radiation therapy with those of the former methods used, it becomes apparent that the introduction of the roentgen treatment with penentrating rays has resulted in great advantage in many lesions. Thus, the following are a few of the results obtained by the former method of treatment in the first group, that is, the proliferations of the lymphocytic cell elements. Holding[55] in treating 35 cases of lymphosarcoma (including large round cell or reticulum cell sarcomas and tumors approaching atypical Hodgkin's disease in histology) by the "superficial" roentgen rays, had 20 patients die within the first year following the treatment; while 5 have disappeared from observation, and only 5 cases lived for one and a half, two, three, three and a half, and four years, respectively (5 cases were still under treatment). Desjardins and Ford,[56] from 55 cases treated (by more intensive radiation) estimated the average life duration of lymphosarcoma as 2.55 years, and Minot and Isaacs,[57] including all lesions having as their main characteristics the progressive enlargement of lymphoid tissues under the general heading of lymphoblastoma, from 477 patients (76 of the patients are still alive) calculated the average life duration as 2.76 years, regardless of whether radiation was given or not. From this they conclude that radiation therapy, though of great value in alleviating symptoms, does not appear "to influence importantly the duration of the disease."

In our cases of lymphosarcoma (excluding the large round cell lymphosarcoma or reticulum cell sarcoma and other atypical forms belonging to Hodgkin's disease), of 16 patients treated by intensive radiation with penetrating rays, only 3 cases died (all within the first year following irradiation), while the remaining patients are well: one for a year and a half; 2 for two years and a half, 3 for three years and a half; 2 for five years; one for five years and a half; 2 for seven years, and one for eleven years (one case unaccounted for after four years from the onset of the disease). While it is too soon as yet to talk of permanent cures, it nevertheless appears certain that as compared with the above figures, the duration of life in lymphosarcoma is considerably prolonged.

In the case of lymphatic leucemia, because of the ineffectiveness of irradiation in the acute forms, we separate this form from the chronic form when tabulating our results. Minot and Isaacs[58] presenting data on 98 cases of chronic lymphatic leucemia, estimated the average life duration as 3.45 years, regardless of whether the patient was irradiated or not (an average of 1.4 years was figured from the onset of the initial symptoms to the time the correct diagnosis was figured). Though we cannot estimate our results from a number as large as that of Minot and Isaacs, it appears that in the case treated so far life was prolonged above the 3.45 year period.

In the second group, that is, the processes where the reticulo-endothelial proliferation forms the main characteristics of the disease (Hodgkin's sarcoma, Hodgkin's disease), the introduction of intensive radiation by penetrating rays did not lead to such a considerable improvement of the results, except for the very early cases and the so-called mediastinal Hodgkin's. Thus, while Klewitz and Lullies[59] from 16 cases treated estimated the average life duration of Hodgkin's disease as only twenty months, Brugmann[60] (from 20 cases) increased this to two and a half years, and Desjardins and Ford[56] (from 73 cases) to 2.7 years. In our 17 cases of Hodgkin's disease treated from 1922 to 1925, nine patients have already died, and only 6 are

alive from one and a half to four years (2 patients unaccounted for). The average life duration of the patients who died was only 2.18 years. Thus it seems that the introduction of intensive roentgen therapy did not improve the previous results with regard to the average life duration. The same holds true for Hodgkin's sarcoma.

SUMMARY

There is extreme sensitivity of the lymphocytic elements; of both the circulating elements and the elements of the lymphoid centers, towards irradiation. Too much irradiation produces rapid destruction of these elements. There is great regenerative and recuperative power of the lymphoid tissues. There is a definite stimulation of the lymphocytic elements by small doses of roentgen rays.

The lesions of lymphoid tissues are classified into three main groups:

A. *Inflammatory Conditions.*

1. *Infectious Lymphadenitis.* The smallest dose of roentgen rays ever used in roentgen therapy (10 to 15 per cent S. U. D.) are given in the acute and subacute forms. A dose of 50 per cent skin unit dose is given in the chronic forms. The results are very satisfactory.

2. *Tuberculous Lymphadenitis.* (*a*) Typical tuberculous granuloma. Both medium and highly penetrating rays are used. A dose between 15 and 40 per cent S. U. D. is given. (*b*) Hyperplastic lymphadenitis. Because the histological structures are similar to Hodgkin's disease, radiation therapy in hyperplastic lymphadenitis is identical to that of Hodgkin's disease. In both types of tuberculosis, radiation therapy is the treatment of choice.

3. In other inflammations, such as actinomycosis, etc., a treatment similar to that used in chronic granulomata is employed.

B. *Conditions Neoplastic in Origin.*

They may be *primary* or *secondary*.

The primary tumors, such as small round cell sarcoma, endothelioma, etc., have a treatment similar to that practised in other malignancies. Lymphosarcoma, reticulum cell sarcoma, and Hodgkin's sarcoma, because of their relationship to other lymphoid tumors are considered together with those conditions in Group C.

The secondary neoplasms, such as carcinoma, sarcoma, etc., have a treatment identical to the primary lesion.

C. *Conditions Occupying Intermediate Position between A and B.*

This group includes a number of lesions having as their main characteristics progressive enlargement of the lymphoid tissues.

According to the radiosensitivity, they may be differentiated into (*a*) proliferations of the lymphocytic cell elements, such as lymphatic leucemia, pseudoleucemia, leucosarcoma and lymphosarcoma, and (*b*) proliferations of the reticuloendothelial cell elements, such as Hodgkin's disease, Hodgkin's sarcoma, and reticulum cell sarcoma. This differentiation coincides with the histopathological distinctions.

The roentgen treatment of these conditions should be generalized and penetrating rays should be used.

1. *Simple Lymphoma.*

The treatment is the same as that for chronic lymphadenitis.

2. *Lymphatic Leucemia.*

(*a*) *Acute lymphatic leucemia.* Roentgen therapy is of no benefit. (*b*) *Chronic lymphatic leucemia.* Stimulative irradiation is given with small doses of roentgen rays of low penetration over the spleen first; then intensive destructive irradiation over the involved regions: lymphatic system, abdominal organs and long bones. The dose amounts to 40 to 50 per cent S. U. D. Apparently no cures are possible, but life is prolonged.

3. *Pseudoleucemia.* This is a process related to chronic lymphatic leucemia. Consequently, a similar dose is administered The treatment is extended to the entire lymphatic system and abdominal organs. The long bones are not exposed to radiation.

4. *Lymphosarcoma.* The treatment is extended over the manifest lesions as well as over the entire lymphatic system and abdominal organs. A 70 per cent S. U. D. is given. The largest tumors disappear within ten days following the treatment. Radiation therapy prolongs life considerably and apparently there are cures.

5. *Large Round Cell Sarcoma or Reticulum*

Cell Sarcoma. The condition is clinically and often pathologically similar to that of lymphosarcoma. However, the radiosensitivity is more like that of reticuloendothelial proliferations. The tumors do not entirely disappear within ten days following irradiation. The dose is 90 per cent S. U. D. because of the lesser radiosensitivity of the cells. Prognosis is not so favorable as in lymphosarcoma.

6. *Leucosarcoma.* Since this condition represents an advanced stage of lymphosarcoma, the prognosis is not favorable.

7. *Hodgkin's Disease.* Because of the lesser radiosensitivity of the reticuloendothelial cells and their derivatives, the response of Hodgkin's disease to irradiation is slower than that of lymphosarcoma. In the very early stages of the disease and in mediastinal Hodgkin's disease, intensive radiation with penetrating rays (70 to 90 per cent S. U. D.) is of benefit. In the rest of the cases only palliation can be expected, and therefore smaller doses with less penetrating rays are indicated. The intensive roentgen therapy with penetrating rays does not prolong the average life duration in this disease. However in the early stages and mediastinal Hodgkin's disease, cures are possible.

8. *Hodgkin's Sarcoma.* Since this condition represents a far advanced Hodgkin's disease, the prognosis is unfavorable. Treatment is the same as for Hodgkin's disease.

Severe blood changes occur following extensive radiation therapy as applied for the above lesions. A careful surveillance of the patient for a period of two to three months following radiation therapy is necessary. Absolute rest, favorable climate, high calory diet, the avoidance of any contact with possible infection, and the administration of blood stimulants, eventually blood transfusions, during this period, are essential.

Statistical results of the different methods of radiation therapy are given.

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CARCINOMA OF THE MOUTH: TYPES AND DEGREES OF MALIGNANCY*

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THE mouth, like the urinary tract, is lined with a protective or covering epithelium in contradistinction to the gland or secretory epithelium of the gastro-intestinal tract. There are also numerous mucous glands lying beneath the protective epithelium with their ducts opening on its surface.

Carcinomas that arise from the regenerative cells of the protective epithelium of the mouth are far more numerous than those that arise from the regenerative cells of the gland epithelium, which naturally incites more interest in the former group. From a practical standpoint carcinomas fall into two general groups, those that arise from the regenerative cells of protective epithelium and are known as epitheliomas or epidermoid carcinomas, and those that arise from the regenerative cells of gland epithelium, known as adenocarcinomas. The first group (epitheliomas) depending on the manner of cell differentiation, is divided into squamous-cell epithelioma, basal-cell epithelioma, melanotic epithelioma, non-melanotic melano-epithelioma, adamantine epithelioma or adamantinoma, and mixed epithelioma. The second group (adenocarcinoma), depending on the manner of cell differentiation, is divided into colloid or mucoid carcinoma, pseudomucinous carcinoma, and so forth.

As a matter of fact, most types of carcinoma have received their names not from the standpoint of cell differentiation but largely according to gross form, density, duration, cause, and so forth. This practice brought out such descriptive terms as papillary, infiltrating, ulcerating, napkin-ring, cystic colloid, encephaloid, scirrhous, fulminating, buyo-cheek, chimney-sweeps', kangri, paraffin, pitch-workers', smokers' and tar. Of all these, colloid is about the only one that signifies cell differentiation. Practically all of the buyo-cheek, chimney-sweeps', kangri, paraffin, pitch-workers', smokers', and tar carcinomas are squamous-cell epitheliomas. One sometimes hears the term, acanthoma alveolaris, which is nothing more than a squamous-cell epithelioma. It would seem that we are trying to complicate instead of to simplify the terminology of carcinoma by converting descriptive terms into entities, as a number of these terms may be applicable to one type of carcinoma.

The so-called mixed tumor is nothing more than an adenocarcinoma that has cartilage and sometimes bone around its

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cells for protection of the host. I have never seen, in the mouth, true basal-cell epithelioma or rodent ulcer, like that of the skin. Melanotic and non-melanotic melano-epitheliomas are rarely encountered; however, they make up about 5 per cent of all the cases of general epithelioma.

In 2,000 cases of general epithelioma the adamantinoma occurred in nine. It bears a close resemblance to the squamous-cell epithelioma and it is thought that it comes from the enamel organ. However, Buchtemann[4] and Kolaczek[5] believe that it originates from the mucous membrane or the mucous glands of the mouth. I have been able to trace it from the regenerative cells of the epithelium of the gum in three cases. In only one case have I known it to metastasize; this case was observed recently. About the only difference between the mixed epithelioma or carcinoma which one sometimes sees in the mouth and the so-called mixed tumor, is that the mixed epithelioma starts from the regenerative cells of protective epithelium and produces both gland and protective epithelium while the so-called mixed tumor acts vice versa. This element is also found in some epitheliomas of other situations, especially the basal-cell epithelioma of the skin. The squamous-cell epithelioma which plays the most important part in carcinoma of the mouth is not only widely distributed, but also has a wide range in its degree of malignancy.

As regards the cause of carcinoma, all lay great stress on irritation. I believe that irritation plays the lesser, and heredity the greater part in the cause of spontaneous cancer. One cannot ignore the great influence of heredity in the face of the facts elicited in the epoch-making work of Maud Slye.[6]

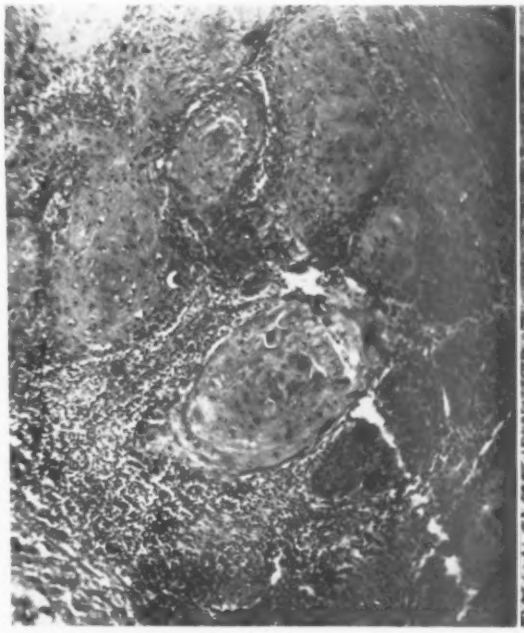

FIG. 1. Squamous-cell epithelioma of the tongue, Grade 1.

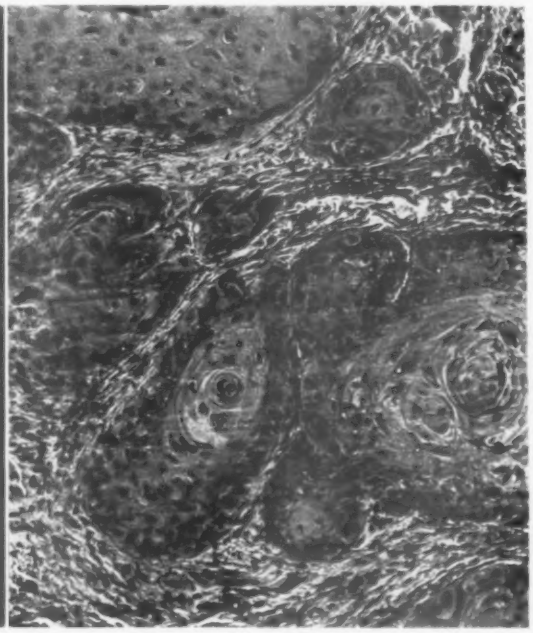

FIG. 2. Squamous-cell epithelioma of the tongue, Grade 2.

In grading the malignancy of these neoplasms, I use the same method, slightly modified, that was first reported in 1920.[1] In the modified form of grading,[2] differentiation or self-control ranging from almost 100 to 75 per cent, and undifferentiation from 0 to 75 per cent represents Grade 1 (Fig. 1); carcinoma in which differentiation ranges from 75 to 50 per cent, and undifferentiation from 25 to 50 per cent represents Grade 2 (Fig. 2); carcinoma in which differentiation or self-control ranges from 50 to 25 per cent, and undifferentiation

from 50 to 75 per cent represents Grade 3 (Fig. 3); and carcinoma in which differentiation or self-control ranges from 25 per cent to practically 0, and undifferentiation from 75 to 100 per cent represents Grade 4 (Fig. 4).

In a paper published recently[3] on epithelioma of the cavities and internal organs of the head and neck I divided 362 cases of epithelioma, from an anatomic standpoint, into eight groups. Four of the groups comprised the epitheliomas of the mouth, such as: Group 1, the tongue; Group 2, the gums, inside of cheeks, lips, floor of mouth and so forth; Group 3, the tonsils, and Group 4, the pharynx and hard and soft palate.

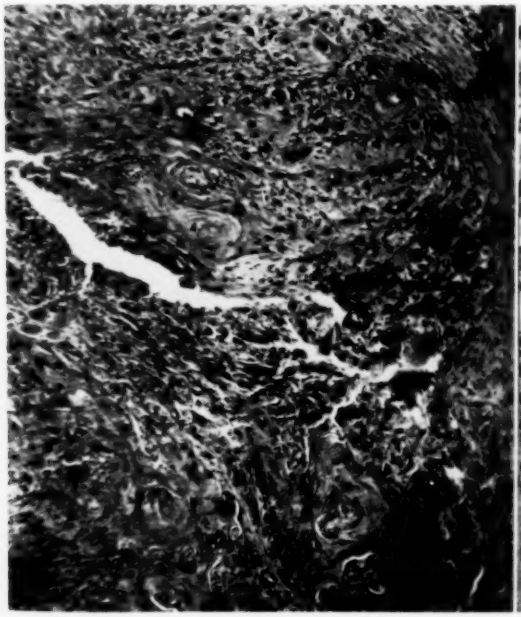

FIG. 3. Squamous-cell epithelioma of the tongue, Grade 3.

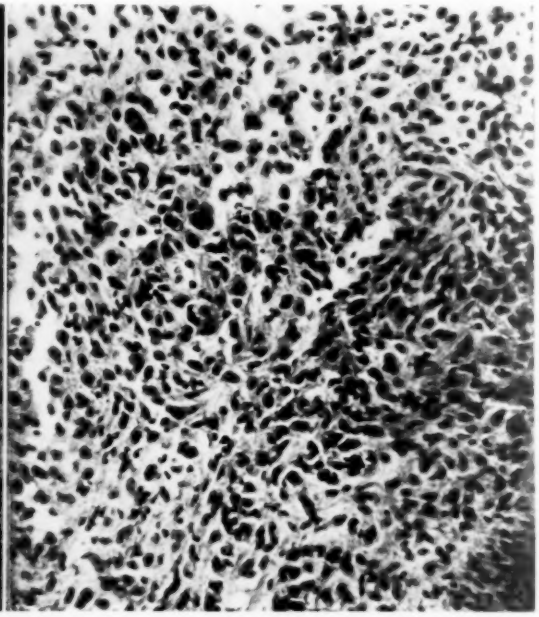

FIG. 4. Squamous-cell epithelioma of the gum, Grade 4.

In Group 1 there were 78 (21.54 per cent) epitheliomas of the tongue; in Group 2, 171 (47.23 per cent) epitheliomas of the gums, cheek, and so forth; in Group 3, 17 (4.69 per cent) epitheliomas of the tonsils, and in Group 4, 17 (4.69 per cent) epitheliomas of the pharynx, hard and soft palate. From the standpoint of malignancy, in Group 1, 1.28 per cent were graded 1; 47.43 per cent were graded 2; 46.15 per cent were graded 3, and 5.12 per cent were graded 4. In Group 2, 7.60 per cent were graded 1; 54.38 per cent were graded 2; 34.50 per cent were graded 3, and 3.50 per cent were graded 4. In Group 3, 5.88 per cent were graded 2; 35.29 per cent were graded 3, and 58.82 per cent were graded 4. In Group 4, 47.05 per cent were graded 2; 35.29 per cent were graded 3, and 17.64 per cent were graded 4. It is obvious that the average of malignancy in cases of epithelioma of the tongue is rather high as a little more than half of the cases were classified in Grades 3 and 4, while there were practically none in Grade 1; even the cases in Grade 2, which represent nearly half of the group, average nearer Grade 3 than Grade 1. Sixty per cent of cases in Group 2 are graded 1 and 2, and 40 per cent are graded 3 and 4. In the cases in Grade 2 in this group there is a lower average of malignancy than in those of Grade 2 in Group 1. About 94 per cent of the cases in Group 3 were graded 3 and 4, while in Group 4 slightly more than half were graded 3 and 4; the remainder were Grade 2.

Of the 362 cases 101 (27.90 per cent) were inoperable; practically all of the remainder were treated surgically. In Group 3, in which the average grade of malignancy was highest the results should

be the least satisfactory, while in Groups 1 and 4 with a similar average grade of malignancy but lower than in Group 3, results should be better, and in Group 2, in which the average grade of malignancy is considerably lower than in the preceding groups, the results should be better than in Groups 1 and 4. After the postoperative deaths, and the deaths from undetermined cause had been excluded, it was found that no good results were obtained in Group 3. In Group 4 good results were obtained in 16.66 per cent; in Group 1 in 20.44 per cent, and in Group 2 in 28.73 per cent.

In the cases of so-called mixed tumor, mixed epithelioma, or carcinoma and the adamantinoma, the average grade of malignancy is low, while in cases of melanotic and non-melanotic melano-epitheliomas it is high.

Since radium has a greater lethal effect on cells in an undifferentiated or immature state than it has on the more mature cells, it seems reasonable to believe that radium is the treatment of choice in the large majority of highly malignant carcinomas of the mouth.*

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* For discussion see page 100.

CERTAIN BENIGN TUMORS OF THE ORAL CAVITY*

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THE importance of benign tumors of the oral cavity depends not so much on accurate recognition, which is usually not difficult, as on a true appreciation of their future life history. Practically all innocent neoplasms are represented in the mouth. However, in certain respects, a number of them are unique in both clinical course and structural arrangement, and it is to this group that special reference will be made.

Upon occasion, benign growths are subjected to influences that materially modify their behavior. Thus if an angioma is invaded by bacteria, the inflammation may result in partial or complete regression of the tumor. Or, at times, a quiescent fibroma through an unknown stimulus, may adopt a rate of growth which closely simulates that of a malignant process. On the other hand, an innocent lesion not only may enlarge rapidly but actually change in nature to become definitely malignant, and finally to produce metastases and death. Papilloma altering to carcinoma affords an excellent illustration.

While it should be remembered that many benign tumors grow continuously and that their development only ends with the life of the individual in whom they grow, nevertheless there are exceptions, and many instances of limited growth period and even spontaneous cure are known.

When the importance of environment in relation to tumors is considered, it will be readily understood that in order to destroy life it is not always necessary that benign growths lose their innocent character. As a classical example, one can do no better than refer to Bland-Sutton's case of a healthy man who died very suddenly under tragic circumstances. At the post-mortem examination, an ovoid lipoma was discovered springing from the left glosso-epiglottic fold. It was suggested that it caused suffocation by blocking the laryngeal entrance during some unusual act on the part of the patient.

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PAPILLOMA

Of all innocent tumors that derive notoriety from a tendency towards malignant transformation papilloma deserves first consideration. The gross appearance of this outgrowing tumor is characteristic. Constructed as it is in its simple form, of a central core of fibrous tissue surmounted by epithelium, two types are recognized dependent upon the relative amounts of these tissues. The epithelial papilloma, although often single, may be multiple and bulky, but in either case is flat or acuminate. The fibrous variety is seen most frequently on the skin, but occasionally springs from the buccal mucosa and then usually from the median raphe of the dorsum of the tongue. The epithelial papilloma also occurs on the skin and all portions of the mouth lining, but it is most frequent on the tongue, affecting any part of it. Many are of congenital origin. A striking feature in adults is the close relationship of papilloma with leucoplakia and syphilitic manifestations, and with glossitis due to the excessive use of tobacco and irritation caused by neglected teeth. In some instances the warty patches are the only areas that show leucoplakia, both processes having arisen concurrently from a common etiology which closely duplicates that of lingual cancer. When the areas are bulky, mechanical irritation may, and often does, produce pain and hemorrhage. Gross ulceration in itself, however, points to a cancerous process.

The tendency of some papillomas to take on rapid growth and ultimately undergo a definite malignant change is well recognized. The additional features which indicate that this has occurred are ulceration, induration at the base and increase in pain. The differential diagnosis of simple papilloma from the papillary type of buccal cancer is at once difficult and important, and microscopic aid is reliable only when the specimen includes the base as well as the surface. Many of the cured cases of lingual carcinoma are in reality simple diffuse papilloma. A careful pathological examination of the complete tumor is at times necessary for an exact opinion. Furthermore, the response to treatment is entirely different in the two lesions. Simple papilloma responds well to radium and is cured by any measure that aims at complete excision or destruction. Incomplete removal is to be deprecated because in many instances it has fostered malignant transformation. In the treatment with radium, surface applications by means of the unfiltered emanation bulb or filtered tubes held in place by dental modelling compound, is all that is necessary. Unfiltered interstitial treatment is seldom justified.

Closely related, are the laryngeal papillomas either single or diffuse. The ease with which they destroy life by malignant change or by suffocation is too well known to be dwelt upon. The technical difficulties of complete surgical removal or endothermic destruction have given radium the opportunity of producing some very striking regressions. The combined use of heavily filtered radium emanation on the outside, and the unfiltered bulb on the inside, has achieved rapid and complete disappearance of the tumor masses in many instances; and the functional result is perfect.

The association of a painful circumvallate papilla and papilloma is too frequent to be classed as a coincidence. The causative factor in both is probably the same or closely allied. Two interesting examples have been observed during the past year in elderly women who were fearful of cancer principally because of the suspicious apprehension of the attending physician. Examination of each patient revealed nothing more than an inflamed papillomatous overgrowth surrounding a circumvallate papilla which was remedied completely by superficial desiccation.

ANGIOMA

A young lad, aged four, was brought to the clinic because of a tumor growing on the palate. The parents stated that with the exception of whooping cough at the age of two, the child had been very healthy. The history given was that fourteen months previously the patient fell while holding a stick in his mouth, the palate being injured sufficiently to bleed. Within three months a pink-colored swelling about the size of a pea was noticed close to the point of injury. The tumor had shown rapid growth since that time, causing an interference, finally, with mastication.

Upon examination the child was found to be normal in every respect except for the tumor. The hospital records describe it as follows: "The entire soft palate and the posterior quarter of the hard palate is the seat of a bulky, pale pink, finely nodular, soft tumor mass measuring 5 × 4 cm. Its greatest thickness is about 3 cm. On the surface are two superficial, yellowish necrotic patches each about 1 cm. in diameter." At this time, it was impossible to determine if the nasal cavity was involved. The clinical diagnosis was lymphangioma.

A few days later, under ether anesthesia, ten unfiltered emanation tubes of 2.5 millicuries total were inserted; at the same time, by digital examination, it was discovered that although the nasal surface of the palate was involved, the greater portion of the tumor presented orally. The tissue removed for laboratory examination was very friable and was composed of a collection of cystic nodules each about one-half the size of a grape seed. When these were squeezed between the fingers, their thin walls ruptured, and small drops of clear watery fluid were ejected. This portion of the growth was nearly bloodless. The microscopical report given by Dr. Everett L. Bishop, pathologist to the hospital, was as follows:

"The surface epithelium is very much thickened and thrown into low folds. While there is marked thickening and fusing of the cells nearer the surface, there is no hornification nor irregularity in the deeper cells. Just beneath the surface, parts of a number of papillae are simply large open spaces, filled with a rather neutrophilic material. These spaces are lined in part by a simple endothelial layer, while in other parts, no lining is seen. Other areas show minute vessels with a "hair-line" lining and filled with the same material. These small vessels and spaces are separated by a loose connective tissue which in places is very cellular, showing many fat spindle cells, with large and dark staining nuclei. This marked cellularity is observed in all parts of the section. Besides the small vessels noted above, there are large collections of small blood-vessels, filled with blood, some of these having thick walls, while others only an endothelial lining, and in places, the small blood-vessels and not the lymph-spaces, are the striking feature."

Diagnosis. Cellular angioma of mixed type.

The response to treatment was rapid. In seven weeks the tumor had disappeared except for a smooth, rounded, bluish prominence the size of a marble. This was obviously hemangiomatous in nature, and probably represented deep-lying tissue which became apparent when the superficial lymph vessel tumor had regressed. Further treatment was carried out by the insertion of five bare tubes having a total value of 1.6 millicuries. In four weeks all traces of the growth had disappeared and the child has remained entirely well.

This case serves to demonstrate what may be accomplished by the use of weak bare tubes in a responsive and delicate tumor situated in a region where surgery, fulguration and cauterization are very unsatisfactory methods. The patient did not complain of pain following treatment and at no time was there visible radium effect. Weak tubes and a small dose are essentials if unfortunate sloughing is to be avoided.

Angiomas are of frequent occurrence in the buccal cavity, and both blood and lymph vessels enter into their structure. They are of congenital or very early formation, and usually have limited growth capacities. However, as Pulford points out, simple angiomas are potentially malignant metastasizing endotheliomas. While it is impossible to recognize primarily the simple tumor that is progressing to a more serious type, rapidity of growth and persistent recurrence after operation, indicate a degree of malignancy which may prove fatal through distant metastases.

Clinically there are recognized two main types of blood vessel tumor, hemangioma simplex, or capillary variety, and cavernous hemangioma. Their distinctive features are too well known to warrant mention. The simple type is rarely found on the lips or in the mouth. The cavernous tumor, on the other hand, while most frequently cutaneous is very common in the mouth, on the gums and especially on the tongue close to the tip. Both lymph and blood vessels participate in the process in certain cases of macroglossia.

The classification of lymphangiomas, is less satisfactory; Wegner (quoted by Ewing) recognizes three types:

(*a*) Simple lymphangioma made up of an anastomosing network of spaces and vessels of small size and appearing as a pale pink patch slightly raised above the level of the surrounding tissue. When it is pricked lymph issues from it.

(*b*) Cavernous lymphangioma consisting of a system of spaces filled with lymph.

(*c*) Lymphangioma cystoides whose structure is a network of small and large cysts lined by endothelium and filled with lymph.

It is generally taught that angioma is either congenital or at any rate commences early in the life of the individual. In many instances, however, the lesion escapes notice until enlargement occurs. With the boy whose history has been given, a definite relationship to trauma is not improbable. This element is also present in those instances of cavernous hemangioma of the gum which are caused by a mutilating dental extraction. Particularly impressive are the cases of blood vessel tumors of the lip and tongue which follow a biting injury by the teeth.

On the question of treatment little need be said. The particular method will be determined by the individual preference of the operator. Whether small stationary angiomas should receive attention at all depends on circumstances; but when they become active and grow, prompt treatment is necessary. If excision is decided upon, the lesion should be cut out, not cut into. If there are deep connections, ligature has yielded good results. Fulguration, cauterization and radium all have their advocates, and all have yielded cures. If radium is used, once again allow the warning to be given that it is better judgment to under-treat than to over-treat.

FIBROMA

This tumor is encountered very occasionally in the mouth cavity. Being composed chiefly of connective tissue, it may grow from both flesh and bone; many are entirely fibrous, while others have incorporated certain glandular structures, the adenofibromas. The neurofibromas spring from nerve trunks, in which instance they often are multiple.

The life history of fibroma is that of a slowly developing tumor which after a certain size is attained may remain stationary because of mechanical interference with the blood supply. When found in close association with mucous membrane, the growth stimulus is probably a catarrhal inflammation. The large fibromas which arise from the periosteum of the jaws seem to be dependent upon chronic trauma, as from a badly fitting denture. As stated before, they are found infrequently in the oral cavity, but when they do occur it is important to recognize their benign nature, to quiet the hysterical alarm of the patient, and to advise excision because of a possible connection with the development of a more serious tumor later on. Bloodgood recorded 12 cases of lingual fibroma in 4 of which cancer developed in the overlying epithelium. The ease with which fibroma becomes sarcoma is, at times, very pronounced. Craver has reported an instance from the clinic of Dr. Quick, in which a neurofibroma of the lower lip changed in character and caused death by pulmonary deposits. There is one type of fibroma of the mouth which is almost a clinical entity; the following report is illustrative:

> A female, aged fifty-five, had worn a complete lower artificial denture for seven years. One year before applying for relief she noticed a lump in the floor of the mouth just in front of the tongue. This slowly grew, and became tender and prevented the use of the plate. When she consulted a dental clinic it was decided that radium treatments were necessary. Upon examination, it was seen that a tumor was growing in the tissues of the floor of the mouth directly behind the symphysis. It was firm in consistency, slightly movable, not ulcerated and about the size of a plum but flatter. The mucosa was thickened and rugose. The growth was excised under novocaine anesthesia, and the histological report by Dr. Bishop confirmed the clinical diagnosis of fibroma.

Similar cases have been seen, 7 in number, and in each instance the tumor grew in the same situation under identical conditions.

EPULIS

In addition to fibroma, there are other benign tumors that occasionally occur in association with the bony structures of the mouth. The list is fairly comprehensive and includes benign giant cell tumor, osteoma, enchondroma, odontoma, dental cyst and epulis. The last named is by far the most common; but in spite of its

frequency it is so often misinterpreted that further consideration would seem to be merited.

Epulis is a topographic term, and may be applied to any tumor of the gum or alveolar border of the jaw. If correctly used it should be qualified by an adjective. Ordinarily it designates a connective tissue growth springing from the submucous tissue or alveolar periosteum; it is a border-line lesion lying midway between inflammation and neoplasm, and is encountered very frequently in young adults. The two jaws are equally liable to be affected, and while no region is immune it appears in order of frequency near the canines, the bicuspids, the first molars and incisors (Scudder). The growth of epulis is in many instances dependent upon local causes such as the irritation of a diseased tooth or the presence of a broken root. Trauma has been known to increase the usual rate of development.

Two distinct types are recognized, the fibrous and the giant cell; the latter is not to be confused with the benign giant cell tumor commencing centrally in bone.

Gruit (quoted by Scudder) describes three periods in their life history:

(1) *Period of origin.* The tumor is not yet visible but is sought because of pain. When it arises in a tooth socket the nerve to the root is pressed upon. The pain may not be referred to any one tooth, but may radiate throughout the surrounding jaw and cheek. Upon careful examination of each tooth, one will be found distinctly tender and, depending upon the stage of growth, somewhat loose. It is in the socket of this tooth that the tumor is developing. As it enlarges the tooth may be pushed out, which when extracted gives immediate relief.

(2) *The period of visible tumor following the extraction.* The patient believes himself to be well until the tumor is seen growing from the alveolus. It is pink and finely mammillated. Ordinarily it is small, like a cherry but it may become as large as an orange; the attachment to the bone is intimate and is more often narrow than broad. The consistence is dependent upon the vascularity and the amount of fibrous tissue present, the giant cell epulis being soft and vascular, at times even pulsating, and bleeding easily upon slight trauma. On the other hand, the fibrous tumor is firm, less vascular and areas of necrosis may develop due to injury.

(3) *A stage of ulceration* occasionally occurs when the growth reaches the large size of some of the giant cell types. It is essentially a pressure ulceration due to bulk and nutritional disturbance.

At times, by reason of an unknown stimulus a rapidly growing epulis of the giant cell class may adopt malignant qualities, invade the jaw bone, recur after removal and quickly destroy life. The recurrences of what seemed to be a simple epulis are apt to become increasingly more malignant. As a general rule the prognosis in the fibrous variety is excellent but it must be guarded in the giant-cell type. Treatment should not be by irradiation; this statement is made emphatically because one instance of it has been observed. The end result is good if the tumor is excised and the base cauterized. For the giant cell type Scudder advises removal of the adjacent teeth and a portion of the alveolus, thereby insuring against the return of a tumor that has been known to become malignant.

MIXED TUMOR

Found in the soft tissues of the mouth is an interesting variety of tumor, which although not innocent in the strict sense of the word, nevertheless for a considerable part of its life, lacks many of the aggressive features that characterize a malignant neoplasm. I refer to the relatively benign mixed tumor, which Ewing designates as an adenoid cystic epithelioma of salivary gland type. The mode of origin is a disputed matter. The German pathologists represented by Volkmann and Wartmann, believed them to be derived from the endothelium of lymphatic channels. This has been vigorously assailed by Ewing, who has adopted an epithelial origin for such tumors, whether found in salivary tissue or in neighboring structures.

The names that have been given to it are both numerous[1] and descriptive: adenoma, glandular enchondroma, cylindroma, perithelioma and adenosarcoma

have been used at times by various writers. The multiplicity of terms arises from the variations in structure. In addition to the epithelium which resembles the basal cells of the epidermis, and which may be derived from branchial remnants or from misplaced salivary tissue, mesodermal tissue in the form of cartilage, mucous tissue and connective tissue are characteristically present in varying amounts. The origin of these elements is epithelial (Ewing) by a peculiar mucoid and cartilaginous metaplasia.

Mixed tumors have a wide distribution, and have been reported in the lip, cheek, orbit and neck. But it is in the tissues of the palate that they are most frequent, and probably spring from aberrant rests due to the close developmental relationship between salivary and buccal epithelium.

In 1922 I reported a small group of these tumors, 7 in number, and since then 2 more have been observed, one being of the cheek and one of the hard palate. Of the original 7, five were on the palate, one of the lip and one of the skin of the forehead. Thus out of 9 cases, the lesion was on the palate in six.

The clinical course is as characteristic as the histology. Innocent in behavior for a considerable period of their history, they are capable, nevertheless, of unrestrained growth and under these conditions may threaten life. Their appearance is suggestive of benignity and they may arise at all ages; the middle period of thirty-five to fifty seems to be the customary one. The tumor ordinarily is of small size, like an olive, and occurs close to the alveolus rather than in the median line. It is smooth, rounded and circumscribed and usually gives the impression of deep adherence and elastic firmness. The overlying mucosa is intact. It is a quiescent growth and may exist unrecognized by the patient for a long period because it causes no symptoms other than mechanical annoyance. After remaining stationary for a considerable length of time—usually several years—it may grow rapidly and penetrate its capsule. Surgical removal at this stage would probably be followed by recurrence, increased rate of growth, invasion of surrounding tissues, ulceration and finally lymphatic spread.

It is very significant that the tumor seldom is recognized clinically, and even at times is misinterpreted histologically. Sarcoma is a frequent diagnosis, and to this may be attributed some startling cures. Successful surgical treatment depends upon an intact limiting capsule. There is no recurrence if the growth is shelled out with this capsule unbroken. Fortunately this is usually easy, but if for any reason enucleation is difficult recurrence is probable. Careful radium therapy should take cognizance of the probable structure of the tumor.

The interstitial use of filtered or unfiltered emanation causes a disappearance of the epithelium and the growth tendency is controlled, but the mesoblastic tissue is influenced to a much less degree. An inert, shrunken, firm mass is the end result, which if objectionable might be excised later with greater safety. The more cellular the lesion, the better is the radiation response. Furthermore, it has been shown repeatedly that the embryonic cell types are radium sensitive which explains why the response of the epithelium of mixed tumors is as definite and unmistakable as with basal epidermal cells elsewhere.*

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* For discussion see page 100.

REPAIR OF DEFECTS CAUSED BY SURGERY AND RADIUM IN CANCERS OF THE HAND, MOUTH AND CHEEK*

BY V. P. BLAIR, M.D.

ST. LOUIS, MISSOURI

FOLLOWING a loss of tissue from a heat burn, a surgical removal, or a mechanical injury, a more or less acceptable repair can be made by first removing the scar or, with proper precautions, the granulations down to normal tissues, and then filling the defect with the most appropriate available tissue. According to circumstances the latter might be obtained by sliding in the neighboring structures, by pedicle flaps, or by free skin grafts. If skin grafts are used, their thickness will usually depend upon whether the derma or only the epithelium has been lost.

In planning the repair, not only must we consider appearances and function of the area repaired, but also that from which the repair material will be taken, and too often in large restorations one's ideas will be pinched by necessity of "cutting the pattern according to the cloth." As nearly as possible we should replace lost epithelium, derma, subcutaneous fat, tendons and resisting fascia with like tissues. Transplants of cartilage, bone and possibly motor nerves, may, at times, be indicated. Non-hair-bearing skin is a good substitute for the oral and pharyngeal mucosa.

Exactly the same rules hold true for restoring areas destroyed or damaged by exposure to roentgen rays or radium, but in practice an added difficulty may arise in these radiation burns and some chemical burns. Within a few weeks after a heat burn and of most mechanical injuries the plane of limit between the devitalized and of the non-damaged tissue has become sharply defined, and it is only when an immediate débridement and repair is attempted that there may be any difficulty in recognizing the demarcation. This is not true with radiation burns, and in débridement of the latter, months afterward one may have difficulty in determining whether he is making unnecessary sacrifices or is leaving tissue of doubtful vitality. This, in conjunction with our natural conservatism, will explain why attempts at repair after radiation burns have given a higher percentage of failures than after any other type of injury. Old radiation burns that have been scarred over for several years are not especially bothersome in this respect. Real difficulties might be encountered in attempting to clean up indolent raw or painful burnt areas that persist in spite of all forms of treatment and neither heal nor make a frank slough. With these latter it is better, when practicable, to remove too much rather than too little, just as in amputating for any endarteritis obliterans and, if immediate repair is made, it should be with tissue of a vitality that can, in healing energy, easily compensate for a possible poverty in the tissue upon which it is to be engrafted. For this reason pedicle or sliding flaps are preferable to free skin grafts if there is any doubt of the condition of arterioles in the field to be grafted, and for such cases pedicle flaps should be used only with delayed transfer. It is probably good practice to delay their transfer very much longer than is necessary for repairs after simpler injuries. A delay of six to eight weeks before making the transfer of tissues from an irradiated area for a radiation burn is better practice than the two or three weeks that is ordinarily allowed on other repairs. With some of these indolent burns, tissue might be conserved and risk of non-union reduced to the minimum by proving the vitality of the base of the defect before transferring the flaps. This can be done by making a débridement with knife or cautery down to apparently healthy tissue and then waiting for granulations to form or to immediately cover the raw surface with large Thiersch grafts. If, from indolence of the base the granulations are poor or the grafts fail to take, little will have been lost and the

* Read at the Eleventh Annual Meeting, American Radium Society, Dallas, Texas, April 19–20, 1926.

débridement can be carried deeper. On the other hand, if the grafts do survive, or healthy granulations develop, it is fair proof that a more formal repair can in all likelihood, be successfully carried out. There can at least be some questioning in these radium burns as to the best manner of dealing with exposed necrotic bone that is still attached. As a rule, it is not good practice to attempt to excise a dead part of a bone before it separates naturally. On the other hand, bone killed by radiation separates very slowly. The application of a soldering iron to kill the indolent area and multiple drilling may hurry the exfoliation.

Carcinomatous changes in the irradiated tissues may further complicate the problem. The simple superficial epitheliomata will not, as a rule, require excision deeper than the subcutaneous fascia and can be immediately repaired. In dealing with these it is usually better to include in the excision the whole area of damaged skin and immediately replace it with a pocket flap or with a free skin graft rather than, as has been the common custom, to make a number of small local excisions and Thiersch graft. There are old roentgenologists who have had a great number of these limited operations on the hands and who still carry much skin that is potentially cancerous, when the whole damaged areas might have been cleared up by a few well planned operations. The neglected epitheliomata and the carcinomata will demand the same excisions or amputations with corresponding glandular excisions, as will similar cancers arising from any other cause.

Whether it is for the treatment of a radiation burn, a cancer, or a distorting scar the consciousness of ability to make an acceptable repair is the greatest stimulant to effective time saving radical excisions.

DISCUSSION ON PAPERS OF DRS. BRODERS, JOHNSON AND BLAIR

DR. DOUGLAS QUICK, New York City. There are so many things in these several papers that it is rather difficult to touch on all. Starting with Dr. Broders' paper, I must say that I am tremendously interested in the method which he and his associates use in classifying these cases, partially, as I take it, with the idea of giving a bit more guarded prognoses and also to govern them somewhat in their plan of treatment. I would like to get fixed in mind a little more clearly the differentiation. I realize it is not a line drawn between one group and the other, and I think it is only by having Dr. Broders keep telling us more about it that we will get more clearly fixed in mind his interpretation of it. As I see it, it is a relative thing, and I think he should keep hammering at us about the various groups.

In Dr. Johnson's presentation of the benign and relatively benign tumors of the mouth I think he has made it clear that certain types can be dealt with very readily. There is one thought I should like to add, and that is, they are not hurry-up cases. Ample time can be taken with them, and this will result in less scar tissue.

Dr. Blair has brought out a number of points. He has shown us what can be done by way of repairing many of the resulting legitimate scars following irradiation. He has also shown us some of the scars that are presented for repair which, in my judgment, should never have existed. In the nose case where the boy was treated with a little radium, and then more, and then a lot, for instance; that is one of the cases that goes down as a radium failure. Radium is damned for what happened to the boy, whereas it should be the fellow who used the radium. I think our experience has rather borne out Dr. Blair's finding regarding the viability of flaps in irradiated tissue. We have had a good deal of difficulty in making repairs unless we have gotten well away from the irradiated area. I think some of the cases he showed us, the extensive growths removed with soldering irons and so on, were remarkable, but I cannot help wondering if the end justified such a procedure—whether more radiation and less cautery, in the beginning, would not have been worth considering.

DR. ROBERT B. GREENOUGH, Boston. If I may, I would like to pay a tribute to Dr. Broders for the work he has been doing in the classification of the malignancy of tumors. I think this is a matter of great importance. We can corroborate Dr. Broders' figures in cancer of the lip as reported by Simmons and Daland[1] of Boston, although the classification was made in three groups instead of four, resulting as follows: In Group I, low malignancy, 53 cases, 81 per cent living and well at the end of three years. In Group II, medium malignancy, 14 cases, 70 per cent living and well. Group III, high malignancy, 4 cases, 22 per cent living and well at the

[1] Simmons, C. C., and Daland, E. M. Results of operation for cancer of the lip. *Surg., Gynec. & Obst.*, 1922, xxxv, 776–771.

end of three years. The lip cases are undoubtedly of lower malignancy as a whole than are those of the tongue. Another series, a group of 59 cases of cancer of the tongue and floor of the mouth (Simmons) treated by cautery, operation and other means, was divided into the exact classification of Dr. Broders; four groups, with the following results: In the low-grade group, 17 cases, there were 12 cures, or 68 per cent. In Group II, 14 cases, there were 3 cures, or 21 per cent. In Group III, 17 cases, there was 1 cure, or 6 per cent. In the high malignancy, Group IV, there were 11 cases, with no cures.

I feel that if there are perhaps 25 per cent of all cases of cancer of such high malignancy, that even in early and favorable cases our present resources are not capable of removing or destroying the disease, it is time we knew it and recognized that fact before we do radical operations upon them. Let us then devote our energies rather to the other 75 per cent in which there really is a chance of cure.

Dr. Broders suggests that because cases of high malignancy are more radiosensitive we should devote our energies to treating these cases with radiation, and reserve our more radical measures for the other more favorable cases. It has been my experience that while we often see a speedy regression of these more malignant tumors under radiation this is apt to be of very temporary benefit, for there is usually a very prompt recurrence, and the disease progresses rapidly to a fatal termination.

Dr. Blair has referred to the widespread effect upon tissues which have been under long continued irradiation, and we may easily believe that a large part of the good effect of radiation, either roentgen rays or radium, is brought about by the dense scar tissue formation in the surrounding tissues. In this way we attempt to strangle the living cancer cells by building up a barrier about the tumor.

Dr. Curtis F. Burnam, Baltimore. Dr. Broders' work should stimulate us all. It means more thorough study and accurate classification, and combined with the gross pathological pictures, it should yield us a more uniform and better plan of treatment.

Dr. Blair's demonstration of what can be done in expert hands in the way of plastic surgery is very stimulating, and I believe he is justified in his view that one can, in the exceptional case, irradiate to destruction with the possibility of subsequent plastic repairs. However, I join Dr. Quick in the opinion that in several of the skin cases, particularly the angiomata, the terrible scarrings shown should never have occurred; it simply means that brutal and unnecessary irradiation methods were employed. The amount of irradiation necessary to cure such conditions does not involve the possibility of serious injuries to the skin, and, indeed, in most cases these lesions disappear without the slightest demonstrable effect on any of the normal tissues. I emphasize this point because some of my surgical associates have been horrified at the thought of the use of radium in angiomas around the face and mouth, particularly in children, and have been willing to submit them to operations that are no beautifiers even in such skillful hands as Dr. Blair's.

Dr. Blair (closing). In presenting this subject it was necessary to at least touch on treatment. While listening to this discussion I counted up the number of people on my list on whom we had burnt out a carcinoma with heat after they had been treated elsewhere with radium and found there were 10 such cases. These radium burns are at times unavoidable when attempting to cure extensive cancer. We have seen a number that had a hole completely through the cheek, but for that grade of cancer this may be good treatment. In repairing a heat burn, using the delayed flap transfer method, we have delayed the transfer for two or three weeks, but I think in a radium or roentgen burn it is well to delay it for six weeks or longer.

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Information of interest to all readers will be found on page ii.

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PRESIDENT OF THE AMERICAN ROENTGEN RAY SOCIETY

1926-1927

UNIV. OF MICH.

EDITORIALS

THE ABSTRACT DEPARTMENT

We venture again to call attention to the abstract department of the Journal. The value of this department depends not only upon the number and degree of excellence of the abstracts but upon the proportion of our subscribers who actually read them.

During the past six months there have been published in this department abstracts of 380 articles in English, French, German, Italian and Spanish periodicals. These have been taken from approximately 140 different publications. This has entailed not only the labor of examining many numbers of each of these publications and making a concise but adequate abstract of suitable articles but also the examination of a considerable number of other periodicals in which no suitable articles have been found. Great care has been taken to completely cover the literature in the languages mentioned above.

The index published in the December number is therefore not simply an index of the original articles published in the Journal during the preceding six months but it is actually an index to the roentgen and radium literature of almost the entire world. Such a body of abstracts with carefully prepared index will not only enable every reader to keep abreast with the work that is everywhere being done but it will be of great value to those who are preparing books and papers on any subject relating to roentgenology or radium therapy.

As volume after volume is published each subscriber will have an increasingly valuable reference library of the literature on these subjects.

A DOUBLE-SIZED ISSUE OF THE JOURNAL

This enlarged number of the Journal is made possible through the coöperation of the publisher and by reason of the fact that the editor had on hand a large number of valuable articles whose early publication seemed very desirable.

There was some misgiving in the minds of many members of the American Roentgen Ray Society when the Section meetings were discontinued because of the amount of material that would thus be lost to the Journal. It was feared that a single annual meeting would not provide a sufficient number of papers to maintain the Journal at its present size of one hundred pages of reading matter in each issue. This fear has proven unfounded. The total amount of reading matter in each issue has been greatly increased by care in paging so as to avoid waste space and by utilizing small type for all case reports, extensive quotations, and for abstracts. In spite of this we find that we have at all times a large number of unpublished articles.

Articles of very high grade are now being received as voluntary contributions to the Journal in much larger numbers than was formerly the case. We take pride in this because it seems to be evidence that the Journal is maintaining its standing among men who are doing the best work. The general make-up of the Journal, including its attractive cover, the excellent grade of paper, the fine reproduction of illustrations and their general arrangement is due to the personal interest of the publisher. The societies of which the Journal is the official organ and the editor owe to him their thanks for his continued interest in producing a journal of which they can be justly proud.

The Journal now has a world wide circulation. We earnestly desire to receive not only original articles from all who are doing worth-while work in any part of the world but we also request information with regard to local societies for our column on Society Meetings, and reports on society meetings and general progress in roentgenology and radium therapy for our Department of Correspondence, Society Proceedings and News Items.

The Journal enters upon this new year

with the first issue of its seventeenth volume with renewed enthusiasm and with many indications that this volume will be an improvement both in size and general average of excellence of material over any of its preceding volumes. To this end we invite your coöperation and criticism.

DOSIMETRY IN ROENTGENOTHERAPY

More than twenty years of endeavor in developing measuring methods and units for use in roentgenotherapy have brought us a considerable variety which tends to lead to misunderstanding if not to confusion. It is sometimes difficult indeed to relate the dose of other investigators to one's own. Not everyone has the necessary data at hand to carry out the painstaking process of calculation required to accomplish this task. The writer has attempted, therefore, in this article, following the suggestion of the Editor of this Journal, to describe the more important methods and units formerly used, and those in general use now, and to give a brief discussion of the measuring apparatus.

The problem of dosage as a whole is very complicated and is by no means solved today; we can easily divide it into a physical and a biological component. The physical side again has to deal with two factors: the quality and quantity of radiation. It is not possible, in an essay of this kind, to separate entirely physical and biological units as their relation appears to be a very close one.

The pioneers in roentgenology who knew that they were dealing with a powerful agent had very few aids to guide their dosage. The oldest therapy was based on pure empiricism; in other words, on personal experience. Furthermore, the old gas tube with its almost uncontrollable fluctuations brought in another element of uncertainty. Inasmuch as in our present work, the Coolidge tube actuated by a transformer is the source of radiation, all statements made in this paper will be applicable to that type of equipment.

QUALITY OF ROENTGEN RAYS

1. *Tube Potential and Minimum Wave Length.* We have learned through the work of Planck, Einstein, Duane, and Hunt, that the minimum wave length emitted from the target of a roentgen tube is related to the potential at the terminals of the tube by the formula

$$ev = h\nu = \frac{hc}{\lambda} \qquad (1)$$

$$\frac{hc}{e} = 12.35$$

$$\lambda = \frac{12.35}{V} \qquad (2)$$

λ expresses the wave length in Å, and V the potential in kilovolts, h is the Planck constant, c the velocity of light, e the charge of an electron and ν the frequency. If we know, therefore, the exact potential which excites roentgen rays, their quality is defined by means of the minimum wave length. This potential can only be measured with sufficient accuracy by sphere gaps (Stenström) of a certain minimum diameter for potentials over 70 kv., and the sphere gap must be connected parallel to the tube and not to the ends of the transformer. Corrections should be made for temperature and atmospheric pressure. The American Institute of Electrical Engineers has given detailed specifications as to the requirements for such measurements. We consider the tube potential measured with a sphere gap as the first method to express the quality of roentgen rays.

2. *Spectrum.* Since the discovery by Laue that roentgen rays may be diffracted by the atoms in the interior of a crystal, the identity of roentgen rays and light rays has been accepted. If we record, on a photographic film, the spectrum from a roentgen beam, using a sodium chloride crystal, this spectrum will give the best idea of the quality of that radiation. One can determine the minimum wave length and calculate with the above mentioned formula (2), the potential at the terminals of the tube. The Seemann spectrograph is an instrument built for use in therapy; this method is very accurate and can be recommended for institutions. The roentgenologist in practice will hardly find time to use this instrument in his daily work.

3. *Half-value Layer.* When roentgen rays strike any material, part of their

energy will be absorbed on the way through. If one uses the same material, for instance, water, aluminum, or copper, the comparison of the amount of absorption in a given thickness expresses the quality of the radiation and allows the comparison of roentgen beams of different penetration. The oldest method employing this idea is the measurement of the half-value layer or half absorption layer, i.e., the quality of a radiation is expressed by the thickness of a certain material which will absorb exactly 50 per cent of the entering energy. Aluminum and copper are the materials mostly employed for this purpose today. Such measurements are best done with an electroscope.*

4. *The Absorption Coefficient.* Closely related to the half-value layer is the so-called absorption coefficient μ. The absorption coefficient is defined by the equation

$$I = I_0 e^{-\mu d} \qquad (3)$$

I_0 is the entering intensity of the primary radiation, I is the outcoming intensity, e is the base of the natural system of logarithms, and μ is the absorption coefficient, d is the thickness of the absorbing material in centimeters. Solving this equation for μ we have

$$\mu = \frac{\log I_0 - \log I}{d \log e} \qquad (4)$$

When measuring an absorption coefficient with the electroscope or any other ionization instrument, it must be remembered that we do not get the pure or true absorption coefficient (μ) but the effect of both absorption and scattering (σ). It is, therefore, sometimes called the weakening or observed coefficient (μ).

$$\mu = \mu + \sigma \qquad (5)$$

Between the half value layer (H) and the absorption coefficient there exists a very definite relation.

$$\frac{I}{I_0} = e^{-\mu d}$$

$$\frac{I}{2} = e^{-\mu H}$$

$$H = \frac{0.69}{\mu} \qquad (6)$$

* The author has worked with the Dessauer electroscope for over four years and can recommend this instrument.

Sometimes the so-called mass absorption coefficient is used; it represents the quotient of $\frac{\mu}{\rho}$, where ρ is the specific gravity (density) of the absorbing element.

5. *Penetrometer.* Based on the phenomenon of absorption, various types of penetrometers have been constructed (Benoist, Walter, Wehnelt). The principle of all these instruments is the comparison of the shadows of metal discs (usually aluminum) of increasing thickness, on a fluorescent screen or a photographic plate, with the shadow of a standard disc of silver or platinum. One cannot expect a great deal of accuracy in this method of defining the quality of a roentgen beam.

6. *The Effective Wave Length.* A very practical method of expressing the quality of a roentgen-ray beam has been given by Duane. He suggests the measurement of the effective or average wave length. The principle is the measuring of the absorption in a given thickness of aluminum or copper. For potentials up to 130 kv., one should use 4.0 mm. aluminum; over 130 kv., 1.0 mm. copper. Graphic charts published by this author, the abscissas of which represent the percentage of the transmitted radiation, and the ordinates of which indicate the effective wave length, enable every roentgenologist to use the method with ease. An electroscope is the best measuring unit for practical work.

The relation between the average wave length and the mass absorption coefficient is

$$\frac{\mu}{\rho} = 193\lambda^3 + 0.13 \qquad (7)$$

Experimentally, it is best to measure the absorption in copper and plot the results on graphic paper, the ordinate showing the thickness of the filter, the abscissa, the logarithm of the transmitted beam. From this curve, the absorption coefficient for copper may easily be calculated according to the formula

$$\mu = \frac{0.69}{H} \qquad (6)$$

7. *The Depth Dose Percentage.* Another way to express the quality of radiation is to measure the so-called depth dose expressed in percentage of the surface dose

which is set equal to 100 per cent. Measurements are usually made in a water phantom at a depth of 10 cm. It is evident that the most penetrating radiation of the shortest average wave length will have the greatest depth dose, all other conditions remaining the same. The measurements must be made with an iontoquantimeter; their difficulty and the numerous possible errors are well known. There are two types of these instruments available: in one model, the falling time of a leaf (aluminum, silver, or gold) is noted; another rather delicate apparatus uses an amplifying device which permits the measurement of the ionization current with an ordinary galvanometer. By connecting a strip chart recording device to this dosimeter, one may get a permanent record of the applied dose during each treatment.

QUANTITY OF RADIATION

1. *Sabouraud and Noiré* (S-N). The first dosimeter used in roentgenotherapy for quantitative measurements was based on the discoloration of barium platinum cyanide under the influence of roentgen rays (Holzknecht (1902), Sabouraud and Noiré (1904)). The erythema dose of this instrument (one Sabouraud-Noiré dose) is equal to five Holzknecht units (H). In superficial therapy this method is still widely used.*

2. *Kienböck Unit* (X). Photographic paper of low sensitivity placed on the treated skin area is exposed to roentgen rays. Developing and fixing must be done strictly according to the rules given by the author. The degree of blackening is compared with a scale calibrated in X units. The relation is

$$1\ \text{S-N} = 5\text{H} = 10\text{X}\dagger$$

This method like almost all other photographic methods is subject to an error due to the selective absorption of silver in the emulsion. For radiation with a half absorption value higher than 2.1 cm. in water, all measurements will give too high figures.

3. *Fürstenau Unit* (F). The Fürstenau intensimeter is based on the fact that selenium changes its resistance under roentgen-ray exposure. The selenium cell is connected to a galvanometer at the ends of a wheatstone bridge. The scale of the instrument is calibrated in F per minute. It is stated that 60 to 70 F of unfiltered, medium soft radiation corresponds to an erythema dose. For filtered radiation the number of F units will be much higher. Several careful investigations have shown beyond doubt that the selenium cell is not constant but shows signs of fatigue, and variations in the readings of 27 per cent have been recorded. A new model is said to permit the correction of this error.

4. *The e Unit.* Friedrich and Krönig introduced the electrostatic unit (e) into dosimetry, based on the measuring of ionization in air. All investigations were done with the well-known Friedrich iontoquantimeter which has a small horn chamber supposed to be independent of the wave length between 130 and 200 kv. A similar unit had been suggested by Szillard who based his measurements on the megamegaion. It may be mentioned here that all ionization measurements are indirect methods as they record the order of magnitude of a secondary effect. No practical method has been found so far to measure roentgen-ray energy directly. Recent investigations which will be discussed later have proved that the relation of the e unit to the biological erythema dose as advanced by Friedrich and Krönig in 1918 must be corrected. Duane suggested the electrostatic unit (E) as a unit of radiation intensity. The dosage would be equal to the number of E times the duration of exposure in seconds.

The best definition has been given by Behnken who defines his unit as follows: the absolute unit of a roentgen-ray dose will be given by that roentgen-ray energy producing in 1 c.c. of air (18°C., 760 mm. pressure) such a conductivity that the amount of electricity measured under saturation current is one electrostatic unit. It is necessary that all secondary electrons be measured and no secondary radiation from the wall of the chamber shall reach the electrometer. This unit has been called one roentgen (R). The so-called French roentgen unit R (Solomon) differs some-

* Photochemical reactions as the liberation of iodine (Bordier and Galimard) or the precipitation of calomel (Schwarz) were also employed.

† This holds true only for unfiltered radiation (half-value layer approximately equal to 1.0 cm. water).

what from the German R unit because it is based upon the amount of ionization per second produced by one gram of radium element (filtered through 0.5 mm. platinum) at a distance of 2 cm. from the ionization chamber. Chamber and radium must be in the same axis. Comparisons have shown that one German R unit corresponds to 2.25 French R units (Grebe and Martius) or 2.66 (Corelli and Vierheller). Every good ionization instrument can be calibrated in e or R units. The only difficulty is to define the unit. It would be desirable to have a standard instrument kept in the Bureau of Standards at Washington, following the example of the Physikalische Reichsanstalt (Bureau of Standards) in Berlin.

5. *Roentgen Value.* Holthusen recommended recently measuring the roentgen energy delivered at 30 cm. focal distance during one minute with the ionization chamber in air, avoiding all scattered radiation. He calls this energy "roentgen value." One can change the distance in order to adapt it to different standard techniques.

6. *Skin Unit.* MacKee and his coworkers have developed a formula representing the surface intensity

$$\frac{\text{Milliamperage} \times \text{voltage} \times \text{time}}{\text{distance} \times \text{distance}}$$

Experiments seemed to indicate that

$$\frac{3 \times 3 \times 4}{8 \times 8} = \frac{36}{64} = 1 \text{ skin unit,}$$

is the amount of radiation which causes the hair to fall out temporarily without causing an erythema. Although it must be admitted that this formula is widely used, there is evidence enough that it can never be as definite as the measuring of the actual output of a transformer and tube. The application of any formula for the calculation of the dose in high voltage therapy should be discouraged.

7. *Erythema Dose.* The best definition of an erythema dose has been given by Seitz and Wintz. It represents that amount of roentgen-ray energy which causes a definite reddening of the skin eight to ten days after the exposure, changing into pigmentation after three to six months. This unit has been a valuable aid during recent years in roentgenotherapy. The principal objection against it as a dose unit is the fact that it is a purely subjective method. Another biological method is the so-called bean method of Jüngling. He exposes the sprouts of *Vicia faba equina* to roentgen rays and defines as a full dose that amount of roentgen-ray energy that completely stops the growth of these sprouts. One erythema dose equals 2.5 full bean doses. Holthusen chose the eggs of *Ascaris megalocephala* for his tests. Four or five days after the exposure, the cultures are counted and the ratio of normal to injured ova recorded. The epilation dose for animals has also been considered as a biological standard.

RELATION BETWEEN PHYSICAL AND BIOLOGICAL UNITS

All recent investigations are directed towards the perfection of a method which permits the expression of biological doses in physically reproducible units. A number of difficulties are encountered. It appears, for instance, that the number of roentgen units required for an erythema dose varies with the average wave length of the radiation (Meyer and Glasser, Wintz and Rump). The construction of a small and fairly constant ionization chamber independent of the wave length would solve this problem. It seems, however, that Glocker has succeeded recently in building a chamber with that property; the experience of other laboratories will prove or disprove his statement. The erythema dose will then be considered as the tolerance dose of the human skin and present the essential connecting link between roentgen energy expressed in physical units and the biological effect.

Ernst A. Pohle, M.D.
Ann Arbor, Michigan.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this column solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. Charles L. Martin, Dallas, Texas.
Twenty-eighth annual meeting, Montreal, Can., Sept. 20–23, 1927.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. Fred M. Hodges, 801 West Grace St., Richmond, Va.
Annual meeting, Washington, D. C., May 16–20, 1927.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. Robert J. May, St. Luke's Hospital, Cleveland, Ohio.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. E. C. Samuel, New Orleans, La.
Annual meeting, Memphis, Tenn., Nov. 14–17, 1927.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St.
Meets second Monday of each month except during the summer months, the place of meeting to be selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. R. A. Arens, Michael Reese Hospital
Meets monthly on second Thursday from October to May (except during month of December) at Virginia Hotel. Dinner at 6 P.M., scientific session at 8 P.M.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. James H. West, 8314 Euclid Ave.
Meetings are held at 6 o'clock at the University Club, on the fourth Monday evening of each month from September to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. Henry L. Ulbrich, 1130 E. Grand Blvd.
Meets monthly on second Friday from October to May, at Wayne County Medical Society Building.

CENTRAL ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. H. C. Kariher, Decatur, Illinois.
Regular meetings held quarterly.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. M. C. Sosman, Peter Bent Brigham Hospital, Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY
Dr. W. W. Belden, 8 West 16th St.
Meets monthly on second Monday, New York Academy of Medicine.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. D. S. Childs, 316 Gurney Bldg., Syracuse, N. Y. Three meetings a year—April, August and November.

PACIFIC COAST ROENTGEN RAY SOCIETY
Secretary, Dr. Harold B. Thompson, Seattle, Wash.
Two meetings a year.

ROENTGEN RAY SOCIETY OF CENTRAL PENNSYLVANIA
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Two meetings a year, April and October.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Eugene Pendergrass, University of Pennsylvania, Philadelphia.
Meets monthly on first Thursday evening, Pennsylvania Hospital.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. S. C. Davidson, Highland Hospital.
Meets monthly on the first Friday evening at 7.45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB
Secretary-Treasurer, Dr. L. R. Sante, Metropolitan Building.
Meets first week of each month. Time and place of meetings designated by president.

TEXAS RADIOLOGICAL SOCIETY
Secretary, Dr. Davis Spangler, Dallas, Texas.

BRITISH EMPIRE

BRITISH RÖNTGEN SOCIETY
Meets on the first Tuesday of each month from November to June inclusive, at 8.15 P.M., at the British Institute of Radiology, 32 Welbeck St., London; W. 1.

BRITISH INSTITUTE OF RADIOLOGY
Secretary, Dr. John Muir, 32 Welbeck St., London, W. 1.
Meets at 32 Welbeck St., but regular dates and times of meeting have not yet been arranged.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8.30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

RADIOLOGICAL SECTION, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. C. A. Anderson, The Hospital, Dunedin.
Meets at Dunedin, New Zealand, during February, 1927.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

CANADIAN RADIOLOGICAL SOCIETY
Secretary, Dr. E. C. Brooks, Montreal.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch.
Meets annually.

* Secretaries of societies not here listed are requested to send the necessary information to the editor.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHOSLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prag, 11/52.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Torino, Torino.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs S. A. Reinberg and S. G. Simonson.
Meets annually.
Fifth Annual Meeting in Kiev, Ukraine, May, 1927.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and S. A. Novotelnow.
Meets monthly on the first Monday at 8 o'clock in the State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies meets every second month except in the summertime:

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Meets in Copenhagen.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets on the first Tuesday of each month from October to July.

THE PHILADELPHIA ROENTGEN RAY SOCIETY

The Philadelphia Roentgen Ray Society held its regular October meeting on Thursday evening, October, 7 1926, at the Pennsylvania Hospital. The meeting was called to order at eight-thirty. The scientific program for the evening was a Symposium on Pyorrhea Alveolaris and Periapical Infection: Clinical Aspect, William A. Jaquette, D.D.S.; Pathological Aspect, J.L.T. Appleton, Jr., D.D.S., Roentgenological Aspect, Leroy M. Ennis, D.D.S.; Surgical Aspect, Robert H. Ivy, M.D., D.D.S. These papers were discussed by Dr. Richard A. Kern, from the medical standpoint, and by Dr. Henry K. Pancoast from the roentgenological standpoint.

The meeting was well attended and everyone present realized more than ever the importance of this great branch of roentgenology.

The papers presented follow in abridged form.

Eugene P. Pendergrass, M.D.
Secretary

SYMPOSIUM ON PYORRHEA ALVEOLARIS AND PERIAPICIAL INFECTION

CLINICAL ASPECT

BY WILLIAM A. JAQUETTE, D.D.S.

Dentistry should welcome every opportunity to exchange thoughts with the members of the Roentgen Ray Society, where our mutual interest meets, and it is a great pleasure for me to speak for my profession when associated with such men as Appleton, Ivy and Ennis.

I shall hope to bring to this discussion for your consideration, the dentist's problem and am sure you will help us in our understanding, not only of the local tissues involved, but also the relation of such tissues, in health and disease, to the whole organism.

Early in the use of the small dental film, the workers made standard ten exposures covering the entire mouth. This is not enough. The roots of the teeth at no place are in a plane. If a study of the teeth is at all desirable, the best result obtainable is our aim, and experience proves that thirteen exposures should be the minimum, seven for the upper and six for the lower.

We all know the difficulty of making detailed pictures of the upper molars, but the upper and lower canines also present obstacles. To best reproduce the upper canines, it would seem worth while focusing on each alone, for in many instances when a tooth adjacent is included, one or the other is distorted. The mandible being narrow, the canine is shown clearly neither with all the incisors nor with the premolars, but very frequently the canine, lateral and central incisors may be included

first on one side in one exposure, then the same three grouped on the other side.

The number of exposures for the examination of a complete denture has been mentioned. The same number should be made for an edentulous or partly edentulous mouth. Only the past week, I received from the roentgen department of one of our large hospitals, a set of dental films in which but seven exposures were used. Because a number of teeth were missing, it was assumed that a study of those areas was not necessary, yet a further examination revealed root fragments entirely embedded. The patient had, for years, worn a partial dental plate supplying the missing teeth.

One of the most conspicuous "cures" I have ever noted, was just such a one. The woman had worn artificial teeth for fifteen years. There was a painful arthritis growing progressively worse, which entirely disappeared following the removal of a root fragment with the treatment of the socket.

After a good set of dental roentgenograms are had, their interpretation is the critical part of our responsibility. Dentists have largely come to believe this cannot be done in the absence of the clinical picture. If the evidence gathered be divided in two parts, that had from the dental films and that had by clinical study, the latter is by far the more important.

Very often a patient presents himself to the dentist bringing a set of dental films and a report that he has pyorrhea. This disturbs the patient because he feels authority has spoken. It may be true, but it also may be a mistake, for many mouths present an atrophy of alveolar process and gingival tissues with no other evidence of pathological change. This may be a senile atrophy or one due to trauma.

When we consider that the force of occlusion may be measured in pounds pressure from 150 to 250 pounds, and that the loss of teeth or the uneven wear may bring excessive stress on the remaining ones, it is no wonder a pressure atrophy develops with resultant absorption of bone. In some cases, we see teeth having lost one half or more of their support still functioning and in apparent health.

Here we may introduce the question, "Are we to extract all teeth which deviate from their maximum vigor?" Some extremists say yes, but it would seem the safe position is between the extremes. When a frank effort is being made to search for all factors contributing toward a local or general pathological change, teeth even under suspicion must sometimes be surrendered, but we will always oppose the ruthless destruction of dentures just because teeth are easier to remove than tonsils, gall-bladder or a section of the colon. Because our patient probably desires to save his teeth, chiefly for appearance, the physician and dentist must not overlook the fact that these teeth are organs of importance, and their conservation is demanded primarily that they may function with the organism as a whole. A physician cannot know just how hard it is for the patient to lose his teeth, unless he, himself, happens to be the patient, and then sometimes, for specious reasons, he decides it is right to keep them.

There is little disagreement in the need for removal of the tooth about the root apex of which there is a manifestly radiolucent area, but from such granulomatous tissue or cyst contents, it may be impossible to obtain a positive culture. The real difference of opinion centers around those individual teeth about the apices of which there may be nothing more than a very slight thickening of the peridental membrane or a lessened calcification of the lamina dura. Suspicion is sometimes drawn to a tooth for no other reason except that it has a root canal filling which is opaque. Had the canal been filled with a translucent material, no attention would have been drawn to it.

In the treatment of patients with such teeth, it is most desirable that the physician and dentist exchange views so that both may know fully the underlying relationship. For patients otherwise in good health, it may be the best course to keep such a tooth under observation. If, however, the physician has evidence that any possible oral sepsis may complicate the disorder, the dentist should know it, so he may act accordingly.

Should all teeth be extracted which are positive roentgenographically, there still may be teeth which require further investigation. A dental abscess drained through a fistula may show not the slightest evidence on the dental film, even though it be sharply defined. This is likewise true in the upper teeth draining into the maxillary sinus. Acute pulpitis makes no record roentgenographically.

In addition to those mentioned, we encounter teeth with putrescent pulps completely liquefied, about which the peridental membrane or limina dura shows no evidence of change. Hopewell-Smith in "The Normal and Pathological Histology of the Mouth" states: "In nearly every case of dental caries there are certain morbid processes found in connection with the dental pulp." If we are to demand a mouth free from all suspicion of infection, we must remove most teeth at a very early age.

The state of society in which we live demands teeth, as it demands clothing. The substituting of lost organs for those which function and meet cosmetic demands is often extremely difficult and frequently impossible. Root amputation has been offered as a means of delaying the loss of teeth. Questionnaires have been broadcast and it would seem that the consensus of opinion is that this procedure is to be resorted to only in the most favorable cases.

Calcareous degenerations of the pulp or pulp nodules frequently are held responsible for pain of obscure origin. In some instances, it is the correct diagnosis, but since the great majority of them give rise to no symptoms, it is always important that all other possible causes be investigated. Another quotation from Hopewell-Smith: "These (pulp nodules) are very frequent accompaniments of inflammation, but they frequently exist also in apparently sound teeth unaffected by caries. It is generally believed that a deposition of calcific material is found in the pulps of elderly people, and, as such is secondary dentine.

"But it is often found in early adult life, and in youth in sound teeth."

PATHOLOGICAL ASPECT

BY J. L. T. APPLETON, JR., D.D.S.

The causes of pyorrhea alveolaris are as follows:

(*a*) *Tartar or Salivary Calculus.* This is rather the result of pyorrhea than the cause. It complicates and aggravates the condition and its removal is necessary in any attempt at cure.

(*b*) *Parasitic.* The available evidence seems to indicate that pyorrhea is not parasitic in origin; however, parasites (pyogenic cocci, particularly α-streptococcus, and spirochetes) are invariably present in the earliest clinical stages of the disease and unquestionably complicate and aggravate the condition. The systemic significance of pyorrhea is almost solely attributable to the streptococcus. In treatment it is certainly logical to employ means of combatting these secondary parasitic factors.

(*c*) *Occlusal trauma*, incorrectly termed "traumatic occlusion." The dominant tendency in the American School of Peridontists is to regard this as the chief factor. Malocclusion from various causes is widespread and results in individual or several teeth being subjected to unaccustomed strains and stresses. The result is an attempt at readjustment which often fails, resulting in the destruction of the investing apparatus of the tooth. There seems to be little doubt that this factor in the vast majority of cases is of the greatest importance.

(*d*) *Downgrowth of "Epithelansatz."* This structure and this process have received emphasis from Gottlieb of Vienna. It is rather too early to judge the significance of this factor.

(*e*) *Systemic (metabolic) conditions* resulting in atrophy of free margin of the alveolar bone. This atrophy is roentgenographically demonstrable even before symptoms are recognizable. Its cause or causes are really unknown, although its appearance is frequently encountered in anemic conditions, in cardiac deficiencies, in nephritics and diabetics.

The pathogenesis of pyorrhea may be visualized somewhat as follows:

An atrophy of the free margin of the alveolus is occasioned either by occlusal trauma or by systemic (metabolic) conditions or by both. The loss of the bone removes the scaffolding supporting the soft tissues of the gum and holding them neatly around the neck of the tooth. The gum tissues in this way and possibly aided by the downgrowth of the "Epithelansatz," fall away from the neck and root of the tooth. The result is a pocket in which stagnation of saliva and food débris occurs, a condition favoring the deposition of tartar and the multiplication of parasites which are always present in the mouth. Inflammation of the soft gum tissues follows, pus accumulates and the destruction of the bone is hastened.

The histopathology of pyorrhea is characterized by: (*a*) atrophy of bone of the alveolus by osteoclasts and halisteresis; (*b*) widening of the peridontal membrane; (*c*) acute purulent inflammation of the tissues.

Periapical infection results solely or almost solely from dental caries resulting in the inflammation and death of the pulp and the passage of bacteria and decomposition products through the foramina into the periapical region. In acute periapical infection, there appears to be no distinctive roentgenographic change. However, in the vast majority of untreated conditions, the periapical tissues react in the form of a chronic proliferative inflammation. The histology of the periapical tissues in this stage is, except in one particular, that of ordinary granulation tissue. This exception depends upon the fact that remnants of the enamel-organ persist in the periodontal membrane as "rests." These rests are sometimes stimulated to proliferate and we have in the granulation tissue one or more epithelial masses. Sometimes, the center of these masses becomes liquefied and a cystic cavity is formed. In this way arises the ordinary dental cyst. Not infrequently in this granulation tissue we also find

one or more small areas of polymorphonuclear neutrophils which represent the acute exacerbations known to mark the course of periapical infection. The proliferation of fibrous tissue and capillaries results in a loss of bone which is roentgenologically recognizable. Not infrequently these inflammatory new growths are rather sharply demarcated from the bone by a capsule of the fibrous tissue.

ROENTGENOLOGICAL ASPECT

BY LEROY M. ENNIS, D.D.S.

The correct interpretation of dental and oral roentgenograms is an accomplishment that every roentgenologist should possess. It should be considered a requisite of modern roentgenology. There are many members of our profession today who think that interpretation of these roentgenograms is an extremely simple matter. This erroneous idea is doubtless the cause of the needless extraction of many useful teeth. Therefore, careful study and judgment must at all times be exercised.

To acquire an accurate knowledge of the anatomy and physiology of the structures involved is the first step toward a correct interpretation. The second step is to become familiar with their roentgenographic appearance under normal conditions; otherwise, it is impossible to recognize any pathologic condition unless it is obvious.

The essential requirements of roentgenograms to be used as an aid in diagnosis may be briefly considered under two classes—the extraoral and intraoral. The first, or extraoral, covers the grosser lesions, such as fractures of the maxillae, impacted or unerupted teeth, large cysts, odontomas and foreign bodies. The second class, or intraoral, covers those cases in which individual teeth with their investing tissues are under examination. It is extremely important that the periodontal membrane and the alveolar bone surrounding the roots, both marginally and apically, be shown to the best advantage. The alveolar process has a characteristic appearance when properly roentgenographed, owing to its anatomic structure and chemical composition. It has a spongy appearance due to the irregularity of the cancellations. The spaces that constitute spongy bone are irregular in shape and size, as the lamellae are arranged in an irregular manner. The groups of lamellae form strands of bone tissue which unite, thus forming irregular shaped cavities. Therefore, in a roentgenogram of normal spongy bone, we see irregular dark areas (no two being alike) surrounded by fine white lines.

When the bone is subjected to injurious influences, the cancellations lose their clear-cut borders and become smaller and closer together. Whenever cancellated structure tends to become regular, ill-defined and homogeneous, the suspicion of a pathologic condition is entirely justified.

As the presence of calcium salts in the bone tends to obstruct the passage of the rays, any increase of this factor will make itself apparent on the photographic negative as an area of greater density or a lighter shadow. A decrease in the normal amount of calcium salts will show an area of lesser density or a darker shadow. Around the individual teeth, there are two structures that have a characteristic roentgenographic appearance and should be studied very carefully when any pathologic condition is suspected; the periodontal membrane, which shows in the roentgenogram as a fine dark line surrounding the roots of the teeth, and the lamina dura, shows in the roentgenogram as a fine white line between the periodontal membrane and the cancellated bone.

If the pathologic process has its origin within the tooth, the first structure to show a deviation from the normal in the roentgenogram is the periodontal membrane, which becomes thickened at the point of irritation. If the pathologic condition continues to progress, hypertrophy of the periodontal membrane continues, causing pressure on the lamina dura, which is finally broken at the point of irritation. With the changes in nutrition that accompany a progressive inflammatory process, there is a decrease of calcium salts in the adjacent alveolar bone, which lessens the resistance to the passage of the rays, causing the photographic emulsion to be more rapidly affected and showing on the negative as a darkened area.

In many cases, we find a thickening of the periodontal membrane is due to such conditions as occlusal traumatism, pressure or chemical influences. We must bear in mind that infection and inflammation are not necessarily synonymous, and that the clinical facts and case history are very important factors in roentgenographic diagnosis.

There are in general two types of lesions in which examination by the use of the roentgen ray is an aid to diagnosis and prognosis: (1) lesions involving the periapical region of the tooth, dependent on infection following death of the pulp, and (2) lesions involving the investing tissues of the teeth, the periodontal membrane and the alveolar process, not dependent on death of the dental pulp, but

in which the infection starts at the gingival margin, so-called pyorrhea alveolaris, or more correctly, chronic suppurative osteopericementitis.

A third type is occasionally seen, the pericemental abscess, in which an inflammatory process is set up in the pericementum of a tooth independently of disease of the pulp. There are three sources of infection. The organism may come in through the gum margin or from neighboring diseased teeth, or it may be carried from other parts by the blood stream.

There are four stages of periapical disease that concern us in roentgenographic work: (1) Chronic proliferative pericementitis, causing a slight thickening of the periodontal membrane about the tooth apex, but without any appreciable loss of bone; (2) chronic rarefying osteitis with granulation. A slight disintegration of bone takes place in a circumscribed area about the tooth apex, bone tissue being replaced by granulation tissue. The tooth apex may project into the bone cavity; may be shortened or roughened from irregular absorption of the cementum, or may present enlargement due to hypercementosis; (3) chronic rarefying osteitis with suppuration. There is an area of bone destruction in which the space is entirely bathed in pus. The roentgenogram presents a blurred area of lessened density as compared with the surrounding bone, and (4) chronic rarefying osteitis with granulation, the cavity in the bone being filled with clear fluid surrounded by a fibrous sac. In the roentgenogram, the cyst appears as a clearly defined dark area.

The first of the various stages of infection of the investing tissues of the teeth beginning at the gingival margin is gingivitis, which is confined to the gum tissue and shows no roentgenographic change. Later, the periodontal membrane is attacked, which shows in the roentgenogram as a thickening of the membrane, starting at the gingival margin and progressing toward the apex of the tooth. Following this, the bone becomes affected, the condition being manifested in the roentgenogram by absence of the apex of the bony septum, called osteopericementitis. The bone surrounding the tooth is now progressively destroyed toward the apex, and in time the bony support of the tooth may be lost.

The roentgenologist must at all times, when diagnosing dental roentgenograms, have in mind caries. Recognizing this condition not only aids the dentist in his treatment, but very often saves the tooth. Cases of neuralgia (so-called) are caused by such conditions, many of which cannot be diagnosed clinically.

In closing, may I repeat what has often been said before: "It is impossible to make a roentgenographic examination of the mouth with ten pictures." I believe fourteen are sufficient, but as many exposures should be made as are necessary to include every tooth and space formerly occupied by teeth in the mouth.

SURGICAL ASPECT

BY ROBERT H. IVY, M.D., D.D.S.

Special emphasis should be placed upon the proper correlation of the roentgenographic findings with the clinical findings. Errors in diagnosis are frequently observed due to lack of coördination between the roentgenologist and the dentist. The more extensive periapical conditions of course, can usually be correctly diagnosed by the roentgen examination alone, but apparent abnormalities of slight extent may be anatomical and not pathological, and doubt is often removed by clinical tests and knowledge of the history of the case. The question of conservative or radical treatment of teeth showing periapical involvement should first of all be decided by the general health of the patient. Our attitude toward suspected teeth in patients who have some systemic condition, in which mouth infection is possibly playing a part, should be much more radical than that adopted in patients having no physical ailments. In patients otherwise healthy, it is sometimes justifiable to attempt to save a tooth, which should otherwise be extracted, by cutting off the diseased apex and curetting out the surrounding granulation tissue. This operation of root resection should be limited to upper anterior teeth in which the area of periapical disease does not involve more than one-third of the root. Immediately before the operation, the root canal should be freshly opened, sterilized and filled to the apex. Under these conditions, the operation should be successful in at least 50 per cent of cases.

Local anesthesia with novocain-adrenalin is preferred to nitrous oxide in surgical treatment of chronic periapical disease, as it is attended by less hemorrhage, and the operative field is thus more free for observation and there is more time for minute attention to the diseased bone and proper care of the tissues to promote rapid and smooth healing after the extraction. The treatment of dental cysts varies according to the size of the cyst. The cyst wall should as a rule be completely shelled out. Up to the size of a large cherry, it is generally safe, after shelling out the cyst lining, to suture the gum flap back in place and allow

obliteration of the cavity by organization of blood clot. In larger cysts, after shelling out the lining, it is often possible to lengthen the flap and turn it in, thus practically filling the cyst cavity with soft tissue.

Impacted teeth have been blamed for many bodily ills. It is our opinion that entirely unerupted impacted teeth are very seldom seats of infection. They may be responsible for reflex disturbances of various sorts. In the absence of general or local disturbances, it is believed better to let impacted teeth alone, since operations for removal are frequently attended by serious consequences.

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DEPARTMENT OF TECHNIQUE

Department Editor: DAVID R. BOWEN, M.D., Pennsylvania Hospital, Philadelphia, Pa.

In this department will be published from time to time, as material is available, suggestions for improvement in technique.

SOME PROPERTIES OF INTENSIFYING SCREENS

BY FRANK E. SWINDELLS, PH.D.

TOWANDA, PENNSYLVANIA

MEASUREMENTS of the speed of intensifying screens have been published by Shearer[1] and Wilsey.[2] As the technique of screen manufacture has advanced since these results were published it was thought desirable to make some measurements of the intensifying properties of more modern screens, and at the same time to develop a quantitative method of comparison for control purposes.

In order to study intelligently the intensifying action of a screen it is necessary to compare the action of roentgen rays on a photographic emulsion with and without intensifying screens throughout a considerable range of densities. The usual method followed for the examination of photographic action is to plot the logarithm of the exposure against the photographic density. The density, which is approximately proportional to the amount of silver reduced, is the common logarithm of the opacity or reciprocal of the percentage of light transmitted.

For ordinary light as used in photography the lower portion of such a curve shows considerable curvature, but as the exposure is increased the curve soon becomes a straight line which continues to a region near the saturation point of the emulsion. The point at which the curve becomes a straight line is dependent on the photographic emulsion used, but in general it occurs at a comparatively low density. On the other hand, when the exposure is made with roentgen rays the toe of the curve becomes much more pronounced and extends to a much greater density before the straight line portion is reached. For a complete discussion of roentgen-ray and white light sensitometry the reader is referred to a recent paper by Wilsey and Pritchard.[3] Roentgen-ray exposures using screens may be regarded as the sum of two processes: (*a*) the action of the roentgen rays on the photographic emulsion, and (*b*) the action of the fluorescent light from the intensifying screen. With a fairly fast screen the latter process predominates. We should therefore expect the sensitometric curves obtained with intensifying screens to resemble most closely those obtained with ordinary light, provided, of course, that the fluorescent light is directly proportional to its roentgen-ray stimulus. That this assumption is probably correct is shown by the curves to follow.

Measurements were made with two types of commercial roentgen-ray intensifying screens, and also with roentgen rays alone. A double coated roentgen-ray photographic emulsion was used, and all exposures were made on the same emulsion, as indicated by the maker's number. The roentgen equipment consisted of a radiator-type Coolidge tube, with tungsten target, and operated at a potential of 60,000 volts peak. The filament current was regulated by hand. Strips of film about 4×18 cm. were placed in a cassette between the screens, which had previously been carefully freed of dust particles. The cassette was placed on a movable support behind a large sheet of lead 4 mm. thick, which was supported vertically. A hole 1.5 cm. in diameter was bored in the center of the lead sheet. By means of its support, the cassette could be moved about, bringing different portions of the film behind the opening. Six exposures were made on each strip and the capacity of the cassette was three strips, or eighteen exposures for each loading. The exposures were varied by changing the time and by changing the distance from target to film, applying the

inverse square law. In order to eliminate effects due to absorption of long wave length roentgen rays by the atmosphere, an aluminum filter 0.6 mm. thick was placed immediately in front of the tube, and another 0.9 mm. in thickness was placed directly in front of the opening in the lead sheet. Possible fogging due to secondary rays entering through the back of the cassette was prevented by lining the back cover with several thicknesses of lead foil. The distance from target to film could be varied from 0.25 to 4 meters. The exposures were made at 3 milliamperes and expressed as milliampere-seconds per meter.

The development was carried out by suspending the strips of film in cylinders containing about 800 ml. of elon-hydroquinone developer with potassium bromide as used in roentgen practice. The developer was freshly prepared each day from the same lot of chemicals. The cylinders were contained in a water bath held at 65°F. The films were developed for five minutes without any agitation. After development the films were quickly rinsed and immersed in hypo for at least twice the time required to remove all visible traces of unexposed emulsion. They were then washed in cold running water and dried in a dust-free atmosphere. This procedure is similar to the usual commercial practice.

The density measurements were made on a Martens-Maximovitch densitometer. Fog corrections were applied by determining the density of the unexposed portions of the strips, and subtracting this value from the measured density. More accurate methods of evaluating the fog correction have been proposed, but it was believed that the general accuracy of the results did not warrant such refinements.

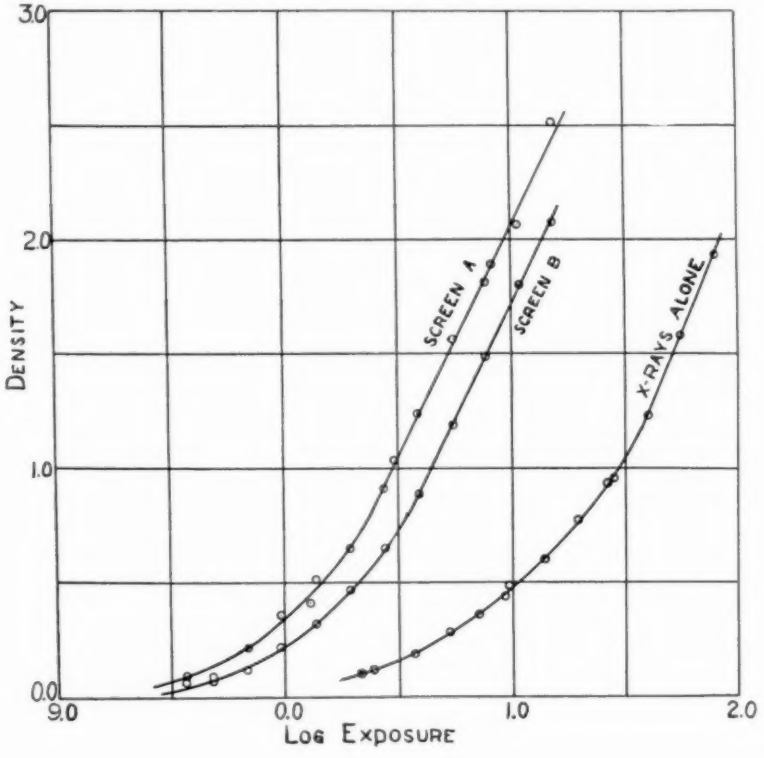

FIG. 1.

The density measurements, corrected for fog, are given in Table 1, and shown graphically in Figure 1. Each value represents a mean of at least three determinations. It will be noticed immediately that the toe of the curve for roentgen rays alone extends up to a density of 1.2. This means

that only above 1.2 density is the density of the negative inversely proportional to the log of the exposure, which is the condition required for a perfect negative. When screens are used the slope becomes constant at a density of 0.8. As the usual working range of densities obtained in a correctly exposed roentgenogram is 0.3 to 2.0, the range of proportionality for the use of roentgen rays alone is about 45

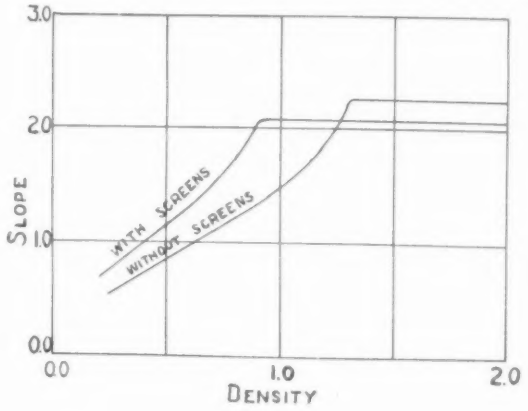

Fig. 2.

per cent of the total, but when screens are used this range is increased to 70 per cent of the total working range.

Table 1

Density as a function of exposure

Without Screens			With Intensifying Screens			
					Density	
Exposure	Log Exposure	Density	Exposure	Log Exposure	Screen A	Screen B
2.09	0.32	0.10	0.37	9.57	0.09	0.06
2.46	0.39	0.11	0.50	9.69	0.09	0.07
3.63	0.56	0.18	0.68	9.83	0.21	0.12
5.13	0.71	0.28	0.98	9.99	0.36	0.21
7.08	0.85	0.36	1.29	0.11	0.42	....
9.33	0.97	0.44	1.38	0.14	0.51	0.32
9.77	0.99	0.49	1.95	0.29	0.65	0.46
13.8	1.14	0.60	2.75	0.44	0.91	0.65
19.5	1.29	0.78	3.02	0.48	1.03	....
26.3	1.42	0.94	3.89	0.59	1.24	0.88
27.5	1.44	0.96	5.50	0.74	1.57	1.19
39.8	1.60	1.23	7.59	0.88	1.81	1.48
56.2	1.75	1.58	8.32	0.92	1.89	....
79.4	1.90	1.93	10.7	1.03	2.06	1.80
			15.1	1.18	2.52	2.07

The slope of these curves determines the contrast. Where the slope is slight, a large variation in exposure produces only a small change in density and a flat negative is the result. Where the slope is steep, a small change in exposure results in a comparatively large change in density and a contrasty negative is obtained. The slope or contrast is dependent on the particular emulsion used and on the extent of development.[4] It will be noted that the curves for the two types of screen have approximately equal slopes throughout, and are, in fact, superposable by multiplying the exposures

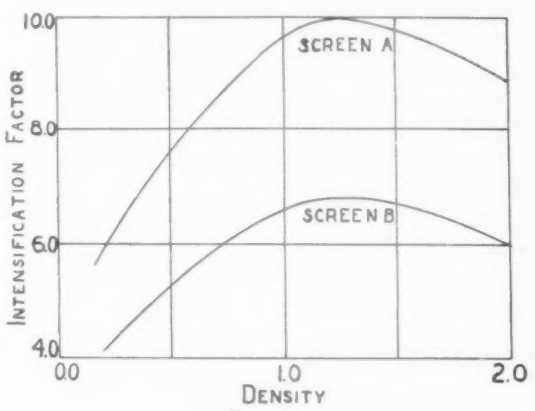

Fig. 3.

of one by a constant factor. In Figure 2 we have the slope or contrast plotted as a function of the density. It will be seen that at the higher densities there is slightly more contrast obtained with roentgen rays alone, but throughout a large part of the range and especially at the very low densities greater contrast is obtained with screens. The average slope throughout the range of densities from 0.3 to 2.0 is about 1.7 where intensifying screens are used, and 1.4 for roentgen rays alone.

The most important property of intensifying screens is their ability to reduce the time of exposure. We may define the intensification factor of a screen (or pair of screens) as the number by which the exposure with roentgen rays alone must be divided to get the exposure necessary to produce the same density with the screen. The curves in Figure 1 permit a calculation of the values of the intensification factor. For a series of densities the logarithm of the exposures are read off, and their differences from the logarithms of the corresponding exposures for roentgen rays alone gives the logarithm of the intensification factor. This calculation is

shown in Table II. In Figure 3 we have a curve showing the intensification as a function of the density. It appears to reach a maximum at about 1.2 density units.

TABLE II

CALCULATION OF INTENSIFICATION FACTOR

Density	Log Exposure			Log Int. Factor		Int. Factor	
	Without Screens	Screen A	Screen B	Screen A	Screen B	Screen A	Screen B
0.2	0.58	0.81	0.97	0.77	0.61	5.89	4.07
0.4	0.90	0.06	0.23	0.84	0.67	6.92	4.68
0.6	1.14	0.24	0.41	0.90	0.73	7.94	5.37
0.8	1.32	0.38	0.55	0.94	0.77	8.71	5.89
1.0	1.47	0.48	0.65	0.99	0.82	9.77	6.61
1.2	1.58	0.58	0.75	1.00	0.83	10.00	6.76
1.4	1.67	0.68	0.84	0.99	0.83	9.77	6.76
1.6	1.76	0.78	0.94	0.98	0.82	9.55	6.61
1.8	1.84	0.87	1.04	0.97	0.80	9.33	6.31
2.0	1.92	0.97	1.14	0.95	0.78	8.91	6.03

The ratio of the speeds of two screens may be readily ascertained from a single exposure, made with the film placed between pairs of the two screens placed side by side, provided the slope of the curve for the film is known and both values of the density fall on the straight line portion of the curve. The film is given the standard development and the densities are read. If D_1 be the density obtained with the first screen and S_1 its intensification factor, and D_2 and S_2 the corresponding quantities for the second screen, and γ the slope of the straightline portion of the curves, then the equation

$$\log \frac{S_2}{S_1} = \frac{1}{\gamma}(D_2 - D_1)$$

follows by the application of simple geometry. The advantages of this method are that the slope has only to be determined once for each emulsion, and only one exposure, whose value need not be accurately controlled, need be made.

In summarizing, we may list the following properties of intensifying screens:

1. They enable better proportioned roentgenograms to be obtained, due to the more uniform contrast resulting from their use.

2. They improve the contrast especially in the lower densities.

3. Their speed appears to be a function of the density of the roentgenogram and reaches a maximum value at a density of about 1.2.

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2. Wilsey, R. B. Tests of *x*-ray intensifying screens. Am. J. Roentgenol., 1920, vii, 196–201; The measurement of intensifying factors of *x*-ray intensifying screens. *Radiology*, 1924, ii, 311–315.
3. Wilsey, R. B., and Pritchard, H. A. Comparison of *x*-ray and white light exposures in photographic sensitometry. *J. Opt. Soc. Am.*, 1926, xi, 661.
4. Wilsey, R. B. The laws of development of *x*-ray films. *Radiology*, 1925, v, 237–244.

Vol. XVII, No. 1

A SIMPLE SAFETY DEVICE FOR WATER COOLED DEEP THERAPY TUBES

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SINCE installing a water cooled Coolidge tube of 200 kv., 25 ma. in our deep therapy work, the human equation which always enters when operating such a unit has caused the loss of two tubes. As in most other installations, there was a separate switch to turn on the water pump. In our case, the operator forgot to close this switch and, unfortunately, the safety device on the pump failed to function at the same time; the result was a punctured tube.

The writer has therefore attempted to eliminate this risk as far as possible by a very simple change of the circuit, so simple indeed that any roentgenologist can install it himself. The motor of our pump (Kelley-Koett model) is connected directly to the 220 A.C. line; a switch with two fuses on the wall opens and closes this circuit apart from the transformer circuit. We removed the feeding wire for the pump from the primary line and connected it to the terminals of the autotransformer in the switchboard (see Fig. 1). There are 220 volts potential difference between the terminals of the autotransformer. When closing the line switch in the switchboard the Coolidge filament of the tube lights up, the rectifying motor starts and at the same time, the motor of the water pump.

One other factor must be considered, that is, the assurance of intact fuses in the

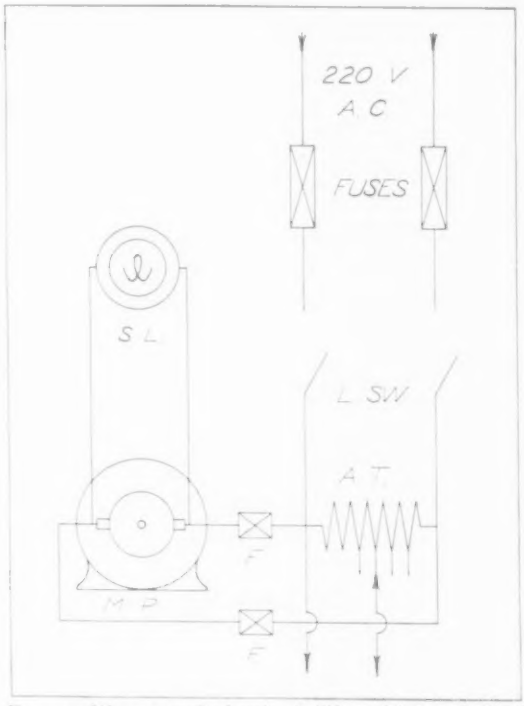

FIG. 1. Diagram of circuit. L.SW = Line switch (in switchboard). A. T. = Autotransformer. F. = Fuses. M.P. = Motor Pump. S.L. = Signal Light.

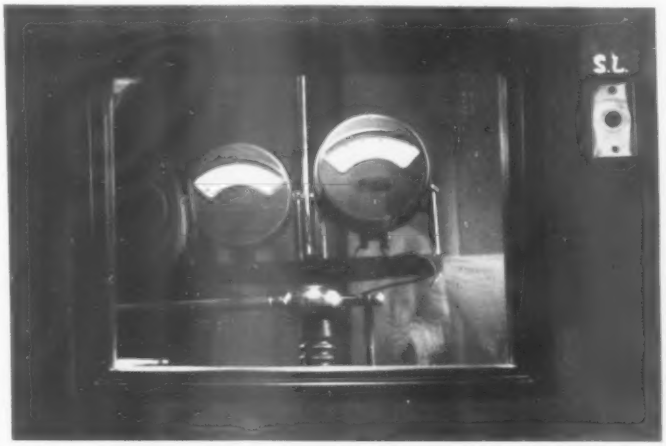

FIG. 2. View of milliamperemeters and signal light (S.L.) in right corner.

motor pump circuit. An ordinary small signal light was connected to the terminals of the water pump motor in the engine room and attached to the wall at the edge of the window behind which the milliamperemeters are installed (Fig. 2). As long as the power reaches the motor terminals the light will burn. The operator cannot help seeing it as it is in the field of vision with the milliamperemeters. The small metal box in which the signal light is placed must be well grounded.

This device has been working very satisfactorily now for over three months, and we feel much safer in running the tube at a high milliamperage as its life is not endangered by an oversight in turning on the pump switch.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

Die Harnorgane im Röntgenbild. (The Urinary Tract in the Roentgenogram.) (Archiv und Atlas der normalen und pathologischen Anatomie in typischen Röntgenbildern. Supplement No. 37 to *Fortschr. a. d. Geb. d. Röntgenstrahlen.*) By Eugen Joseph, M.D., Berlin. Paper. Price, 31.50 Marks; Bound. Price, 36 Marks. Pp. 58, with 23 text figures and 153 illustrations on 38 plates. Leipzig: Georg Thieme, 1926.

The roentgenogram has assumed such a significant position in urology that a collection of the more important urological roentgenograms in the form of an atlas becomes a necessity not only for the urologist but also for the surgeon, internist, roentgenologist and even the general practitioner. The need for such an atlas is self-evident and Professor Joseph has sought to satisfy it for the German reader in the volume under review. However, although the introductory text is in German, the 153 illustrations constituting the Atlas are described in German, English, French and Spanish, a feature which appreciably enhances the value of the work.

Knowledge of the normal silhouette of the urinary tract is absolutely necessary in any study of the pathological alterations. In order to provide an adequate basis, the author has determined the normal features of the urinary tract and variations of the normal roentgenological shadow. Special emphasis is placed in the introduction on the various sources of error in order to guard the reader against possibly serious or useless procedures. The matter of cystoscopic technique is not touched upon in this volume.

The book consists of four brief introductory sections followed by the atlas proper. The first section deals with the technique of urological roentgenography and touches upon the preparation of the patient, the technique of roentgenography and the filling of the urinary system with contrast medium. The second section deals with the roentgenographic characters of the normal urinary system. The third section deals with the roentgenography of the pathological kidney and ureter. Under this head are mentioned: (a) malformations; (b) displacements, hydronephrosis; (c) acute infections, chronic infections; (d) stones and artefacts; (e) neoplasms; (f) pathology of the ureter. The fourth section deals with the roentgenography of the normal and pathological urinary bladder, the prostate, urethra and seminal vesicles.

The quality of the illustrations is exceedingly good and the selection presented should prove valuable for reference purposes and intrinsically instructive as well.

B. Cohen.

A Practice of Physiotherapy. By C. M. Sampson, M.D. Cloth. Price, $10.00. Pp. 620, with 146 illustrations. St. Louis: The C. V. Mosby Company, 1926.

This book represents a serious attempt to establish physiotherapy on a firm basis and the author is to be commended for his devotion to the subject. His method of handling it, however, is open to criticism, and his argumentative style arouses antagonism even in a reviewer who is friendly both to the author and his subject.

One of the worst faults of the book is its verbosity. The introduction which rambles over seven pages could have been disposed of in one. The same fault prevails in many other parts of the book, making it very difficult to find the whole grains in the great quantity of chaff.

As it now stands the book can be read with profit only by one who has had considerable clinical experience and also experience in the use of the physical measures advocated. If future editions could be amended so that the reader could learn more of the subject and less of the author, and if the special pleading and the setting up of straw men in order to knock them down could be eliminated, the book would have real value for the valuable information that is now practically buried in it.

E. A. Merritt.

BOOKS RECEIVED

Scoliosis, Rotary Lateral Curvature of the Spine. By Samuel Kleinberg, M.D., F.A.C.S., Assistant Surgeon, New York Hospital for Ruptured and Crippled; Chief of Orthopedic Service, Israel Zion Hospital of Brooklyn. Cloth. Price, $6.00. Pp. 311, with 140 illustrations. New York: Paul B. Hoeber, Inc., 1926.

PNEUMOCONIOSIS (SILICOSIS). By Henry K. Pancoast, M.D., Professor of Roentgenology, University of Pennsylvania; Roentgenologist to the University Hospital, Philadelphia, Pa.; Consulting Physiologist to the United States Bureau of Mines, and Eugene P. Pendergrass, M.D., Associate in Roentgenology, University of Pennsylvania; Assistant Roentgenologist to the University Hospital, Philadelphia, Pa. Cloth. Price, $4.00. Pp. 186, with 23 illustrations. New York: Paul B. Hoeber, Inc., 1926.

ANLEITUNG ZUR DIATHERMIEBEHANDLUNG. By Dr. med. G. Bucky, New York. Second edition, revised. Paper. Price, 6 marks. Pp. 200, with 132 illustrations. Berlin and Vienna: Urban and Schwarzenberg, 1927.

INTERNATIONAL ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

BRUNNER, A. The complication of the roentgen diagnosis of the lungs after operative procedures in the region of the thorax wall. *München. med. Wchnschr.*, Jan. 1, 1926, lxxiii, 21–24.

Under normal conditions the uniform arrangement of the bone shadows does not ordinarily cause erroneous interpretations. Marked calcifications of the costal cartilages will be taken for calcified disease foci only by the beginner. The soft tissues (skin and muscles) are so evenly distributed over the chest wall that their shadows do not cloud up the lung picture. However, if the roentgenogram is taken in the sagittal plane, the thickness of the soft tissues becomes appreciable and gives rise to a narrow shadow stripe over the clavicle. Operative procedures in the thorax wall (thoracoplasty) may so alter the normal arrangement of bone and soft tissues and produce abnormal proliferations or deeply retracted scars that the roentgenogram in such cases will show unusual shadows and rarefactions that may be confused with localized pneumothoraces or intrapulmonary cavitation. In doubtful cases a palpation with the patient before the roentgen screen will serve to differentiate the superficial nature of the condition from a suspected internal condition.

A few illustrative examples are cited.

BUSCH, WERNER. Calcifications in the arteria interossea volaris. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 954.

An illustration is presented showing isolated calcifications outlining the course of the artery upon the membrana interossea. The calcified areas appear segmented, with small interspaces. The degenerative processes seem localized mostly in the median and lateral walls of the artery. This is explained as being due to the anatomical position of the artery upon the membrana interossea whereby the dorsal and ventral walls suffer less pressure and tension changes than do the lateral and medial walls. Another interesting feature in this illustration is the absence of visible calcifications in the radial and ulnar arteries. This fact may possibly throw some light on the genesis of certain arteriosclerotic changes. The individual in whom the above picture was found was a fifty-eight year old man, very robust and without other signs of arteriosclerosis.

CHUTE, ARTHUR L. A study of some cases of hypernephroma. *Boston M. & S. J.*, March 18, 1926, cxciv, 471–478.

The medical practitioner particularly should be impressed with the fact that no hematuria is to be looked upon as unimportant until it has been traced to its source and found to be due to an unimportant lesion. This will enable cases of hypernephroma to receive early proper treatment. Warning in the shape of hematuria appears in many cases years before the growth begins to take on serious activity. In this early stage the growths may be removed with little immediate mortality and with good prospect of no recurrence. The results of treatment of the older cases are not very good. A careful investigation of a case will permit an accurate diagnosis in most instances much earlier than has been the case in the past.

The pain of hypernephroma is not characteristic, especially in the early stages, and little help can be expected from this symptom in arriving at a diagnosis. The only two symptoms that may be depended on are hematuria, and also change in the size and contour of the kidney.

In the roentgenographic investigation of the disease either before or at the time that a pyelogram is made one should make sure that the outline of the kidney is well brought out. This outline will almost invariably show an increase in size or irregularity of the kidney even in patients with deep loins in whom at times one can palpate nothing suspicious. An irregularity in the contour of the kidney as shown by the roentgenogram, especially a bulging in the center or a knob at one pole, should raise a very definite suspicion of a hypernephroma and lead to an exploratory incision. Even in the cases where a tumor mass is felt, and this happens in a good proportion of advanced cases, there may be a misinterpretation of this mass which may lead to a still further delay in the patient receiving proper treatment.

In the present series, tumor of the kidney on the right side was in 2 cases confused with a big gall-bladder. The mass in each case seemed to be right under the abdominal wall and too movable to make it seem probable that one was dealing with anything but a gall-bladder.

This matter could of course have been settled had a pyelogram been taken; and the real difficulty is to encourage a sufficient doubt in the observer's mind to have this measure carried out.

The above conclusions are based on a study of 43 cases that have come under the observation of the author. Hypernephroma was ten times more common in males than in females (39 men, 4 women). The condition is rare before the age of thirty but it is common after the fourth decade. In only one instance were both kidneys involved. Of the 37 cases treated by operation 33 showed hematuria as a symptom, 27 pain and 27 palpable mass in the loin. There were 5 deaths due to operation, while in 5 other cases no attempt was made to remove the kidney owing to the presence of metastases. The non-operated cases all died. Some of the operative cases have done well but the number has been rather small. The discouraging results point to the necessity for catching this condition early, which can be done only if attention will be paid to it.

DYROFF, RUDOLF. "Contrastol," a new contrast material for the delineation of cavities of small caliber. *Deutsche med. Wchnschr.*, March 5, 1926, lii, 397–399.

The iodine in lipiodol is not nearly so firmly fixed as is assumed. This iodine is released, for instance, by the action of gastric juice and also during the process of resorption from the peritoneum. Apart from the danger of iodine intoxication, there is also the possibility that the irritation produced by the iodine upon mucous and serous surfaces may be such as to cause subsequent adhesions.

The author has sought another compound containing bromine which is less easily decomposed, and he suggests "contrastol" for this purpose. Nothing further is stated as to the composition of this material except that it is an oily substance containing bromine which is not liberated even by heating up to 170°. This gives perfect assurance of sterilizability. No bromine is liberated from the material by the action of acid or alkali within physiological limits. Animals have tolerated relatively large injections of this substance without injury. Its employment in humans has thus far shown no toxic sequelae. Operative inspection of a previously injected area disclosed not the least signs of irritation from the "contrastol." Bromine begins to be excreted through the urine only when large accumulations of the material are produced in the body. This excretion is at a relatively low level and suggests the use of the material for continual, slow bromine medication. The oil depots are demonstrable roentgenologically weeks or months after the injection.

This contrast material has been employed to demonstrate the patency of the fallopian tubes. It was introduced dropwise into the uterine cavity without the employment of pressure until the first uterine contraction occurred. This contraction ejected the material from the mouth of the uterus, but at the same time a small portion entered the open tubes, as was demonstrated by roentgenograms. This procedure has certain diagnostic value in questions of sterility, permits the location of a stenosis and a visualization of alteration in shape of the tubes in the case where there is communication. Moreover, the various types of tumor occurring in the genital adnexa can be distinguished and outlined to some extent by the use of this material in cases where the mere palpation or simpler procedures are unsuccessful.

It is suggested that this material can serve as a carrier for medication. Another therapeutic application is its use in demonstrating the effects of uterine tonics by testing the capacity and sensitivity of the uterus with the oil in place. By the use of this material the author has demonstrated for the first time that there exists a natural peristalsis in the fallopian tubes. This peristalsis is very sluggish during the intermenstruum, but becomes greatly accelerated shortly before beginning of menstruation. The uterine capacity also has a cyclic variation. During pregnancy there is a decided atony of the uterine musculature which is in distinct contrast to the hyperirritability when a tumor or foreign body is present. The author has recently demonstrated the patency of the tubes during the first months of pregnancy.

"Contrastol" is useful also in the partial delineation of the male genital passages; the outlining of the bronchial tree, cavities, and other applications in pulmonary diagnosis; in gastrointestinal diagnosis it is especially useful in showing the finer changes; for outlining the urinary passages; for the cerebrospinal canal; for intraabdominal organ diagnosis; and the demonstration of fistulas. The substance was found to be unusually valuable for injection of blood and lymph vessels in anatomical preparations. In all of the above applications "contrastol" was compared with lipiodol and found to give the same depth of shadow while at the same time possessing greater clinical advantages.

HAVLICEK, HANS. The gallbladder-duodenum fistula in the roentgenogram. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 944–948.

We know today that cholecystitis may occur without the presence of stones and also that

it is possible for gallstones to be present without producing symptoms in an individual. The primary factor is difficult to specify; but it seems probable that a primary injury to the wall is an etiological factor. Extensive researches, especially by Americans, have demonstrated that histological signs can be demonstrated in any gall-bladder that has once undergone pathologic change in its walls.

A report is given of a case occurring in a woman aged sixty-one. She had been complaining of stomach pains, and an abdominal roentgen examination was made. No pathological changes were observed in the large intestine during the examination of the contrast enema. On the other hand, the filling of the stomach with barium suspension disclosed a very interesting finding. The stomach was fairly ptotic, shaped like a rounded fish hook and of medium tonus. Peristalsis appeared only after prolonged palpation. Neither curvature showed signs of pathological change in contour. During compression of the abdomen the pyloric portion and the duodenum appeared to be held back somewhat and gave the impression that the motility of the pyloric portion was greater during large respiratory movements than when drawing in the abdomen. The bulbus duodeni became filled in about five minutes but the filling was very temporary. Examination, in the recumbent position especially, showed the bulbus on palpation to have a fine toothed outline which appeared as if caused by periduodenal adhesions. There was no spasm or any evidence pointing to an ulcer. On observation one could note the sudden upward movement of a thin stream of barium from the bulbus into a cavity which was external to the duodenum and which had a convex lower outline. This seemed on first impression to be an unusually large duodenal diverticulum. More exact study, however, showed that the cavity was filled from below and not by overflow from above. The condition turned out to be a fistula between the duodenum and the gall-bladder which according to the author has not been described roentgenologically.

In this case there was apparently a gall-bladder inflammation associated perhaps with gallstones and stenosis of the cystic duct. After a fusion with the duodenum there developed a fistula between the two cavities. There must have been a continued obstruction in the duct since otherwise the fistula would have closed. From the clinical history it is concluded that the fistula was in existence for a period of six years. The "stomach pains" complained of by the patient were undoubtedly caused by the stagnation of duodenal contents entering the gall-bladder. Owing to the advanced age of the patient and a concurrent diabetes no operative correction of the condition was attempted.

LARIMORE, JOSEPH W. Cholecystography. *Radiology*, February, 1926, vi, 156–158.

In the practice of cholecystography by oral administration of the dye the control of the alimentary factors is essential. Interpretation should consider the alimentary reaction as well as any opacities of residual capsules or precipitation of the dye. Only a definite gall-bladder shadow has a clinical value. The absence of the shadow in the oral test is inconclusive especially when there is associated an alimentary reaction or a large alimentary residuum of the dye. Reduction of the dose, and achievement by further experiment of better control of the alimentary factors may be expected to give more constancy to the results of cholecystography by oral administration.

The effective dose of the tetraiodophenolphthalein salt as used orally for cholecystography is determined by the free acid of the gastric contents. When using 5 grams of the dye in five salol coated capsules the cholecystogram has been disturbed (1) by the alimentary reaction following the full solution of the dye permitted by gastric achlorhydria, and (2) by inadequate solution of the dye resulting from full active hydrochloric acid gastric secretion which precipitates the dye or prevents dissolution of the salol coated capsules.

LEWALD, LEON T. Roentgen diagnosis of syphilis of the stomach. *Radiology*, February, 1926, vi, 138–145.

The roentgen-ray evidence offers the best means of making a tentative diagnosis of syphilis of the stomach. Demonstration of improvement after antisyphilitic treatment in the anatomical appearance and functioning of the stomach, together with improvement in the physical condition of the patient such as gain in weight, cessation of vomiting and disappearance of pain or distress after ingestion of food tends to confirm the diagnosis. The gastric involvement in syphilis is more extensive than in simple ulcer and may be *as marked as in gastric carcinoma*.

The absence of history or signs of syphilis, a negative Wassermann reaction or even the histological appearance of a section from the stomach (unless accompanied by the demonstration of *Spirochaeta pallida*) do not exclude the possibility of the presence of syphilis of

the stomach; nor, on the other hand, does a positive Wassermann reaction prove the specific nature of a stomach lesion. The presence of a palpable tumor, absence of free hydrochloric acid, and loss of weight, unless accompanied by unquestionable roentgen appearances of gastric carcinoma should never lead to a final diagnosis of carcinoma of the stomach; but, on the contrary, in atypical cases the patient should be given the benefit of antisyphilitic treatment as a therapeutic test.

Gastroscopic examination together with removal of a section for microscopic examination may at times be of the greatest value in making the diagnosis of syphilis of the stomach. Definite proof of syphilis of the stomach rests upon the demonstration of the presence of *Spirochaeta pallida* in the gastric lesion. However, as a basis for treatment, roentgen-ray evidence is sufficient to give the patient the benefit of antisyphilitic treatment and to avoid extensive resection of the stomach. Certain cases may require operative relief by the performance of a simple gastroenterostomy.

The roentgen findings of syphilis of the stomach are: (1) diminished size accompanied by almost immediate evacuation of most of the stomach contents. There is often compensatory dilatation of the esophagus in this type of case; (2) deformity of the stomach of fairly symmetrical nature involving a large portion of the middle of the body of the organ, producing a dumbbell-like appearance. When this appearance is found in a young individual, or in an older one without the characteristic appearance of cachexia, commensurate with a malignant involvement of the stomach of the extent indicated by the roentgen findings, syphilis of the stomach should always be suspected, and if a positive Wassermann reaction is obtained the diagnosis is established with reasonable certainty; (3) in cases showing a remarkably small tubular stomach, commonly spoken of as linitis plastica, the problem is more difficult as this condition even in young individuals may denote carcinoma. In other instances the condition may be a fibromatosis, while in others it may be due to syphilis; (4) in another class of cases the roentgen appearances are very similar to those in carcinoma and consist of localized areas of infiltration of the stomach wall, but the lesion may be as extensive in syphilis as in carcinoma; (5) the lesion may be situated at the pylorus and produce marked stenosis and gastric retention. In this respect the condition resembles that observed in ulcer or carcinoma of the stomach, but it is always more extensive than the lesion in simple ulcer.

Two cases are cited.

MAYER, ERNST G. Differential diagnostic considerations in extensive destructive processes of the temporal bone exemplified in a rare case of practically complete destruction of the pyramids by a cholesteatoma. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 889–893.

The patient was referred for a roentgen examination after the following clinical diagnosis: right chronic suppurative otitis media, granulations at the posterior superior wall of the auditory canal, retroauricular fistula, paresis of the right branch of the facial nerve. The roentgen examination disclosed a surprising condition. There was practically complete destruction of the pyramids. The whole pars mastoidea and the pyramids were included in one large defect which left intact only a portion of the cortex. The boundary of the pyramids against the posterior cranial fossa was almost entirely absent. The tegmen still appeared intact but the posterior and anterior walls of the auditory canal were gone. The median portion of the anterior wall of the tympanic cavity was partly retained. The labyrinth was completely destroyed. The destructive process extended medially into the pyramidal zone through which it had penetrated into the median cranial fossa. The outline of the defect was sharp and smooth as in a cholesteatoma. The operation completely verified the roentgen finding.

Extensive destructions of the petrous portion of the temporal bone may be due to either carcinoma, sarcoma, tuberculosis or cholesteatoma. If the defect is distinctly outlined from its surroundings the first suspicion should be toward carcinoma or cholesteatoma. An irregular, somewhat hazy outline suggests carcinoma, while a uniform smooth outline is characteristic of cholesteatoma. The presence of local metastases proves the existence of a malignant tumor. An indistinct outlining of the defect against its surroundings in the roentgenogram giving the impression of an extensive diffuse atrophy of the pyramid is characteristic of sarcoma or tuberculosis. If the wall of the antrum is still readily recognizable this would speak against tuberculosis, and a forward bulging of the planum mastoideum denotes sarcoma.

MONROE, ROBERT T., and EMERY, EDWARD S., JR. X-rays of the chest: Their use in tuberculosis suspects. *Boston M. & S. J.*, Apr. 8, 1926, cxciv, 619–623.

One frequently sees patients complaining of vague symptoms in which the possibility of an underlying tuberculosis presents itself and in which a roentgenogram of the chest is

most helpful in showing quickly and easily the presence or absence of a pulmonary process. The frequency of negative roentgen reports tends to deter the physician from subjecting a patient to unnecessary expense and worry. The following study was undertaken to determine how far one is justified in using the roentgenogram in this type of patient and in what way one may best choose his cases for roentgenographic examination. Examination was made of 188 consecutive cases appearing in a dispensary of the Peter Bent Brigham Hospital, Boston, and after diagnosis was agreed upon, the patient was sent to the roentgen-ray department for study (107 presented themselves to the roentgen-ray department). These patients were to all intents and purposes examined under conditions closely resembling those under which a general practitioner would be working. Upon receipt of the roentgen-ray report these cases were divided into four groups: Group I: cases with positive clinical diagnosis and positive roentgen-ray finding; Group II: cases of positive clinical diagnosis and negative roentgen-ray findings; Group III: cases with negative clinical findings and positive roentgen-ray diagnosis; Group IV: cases with negative clinical and roentgen-ray diagnoses.

A review of the physical findings showed clearly that the physical signs in Group I were somewhat more definite than in Group II, although as a whole there was surprisingly small difference between them. The physical findings in Group III cases showed nothing to justify a diagnosis of tuberculosis. The physical findings in Group II were definitely suggestive of pulmonary tuberculosis.

Study of the roentgenograms showed rather decidedly that the pulmonary processes in the Group I cases were much more advanced and more definitely active than those in Group III, but this fails to explain why the physical signs in Group II should have been more suggestive of tuberculosis than those in Group III. Of the cases in Groups II and III the symptoms were much the same but the physical findings were quite different. In other words, in these cases representing about 20 per cent of the series the clinician did not agree with the roentgenological findings because of the physical examination.

The results seem to indicate clearly that chest plates should be taken of all patients whose symptoms suggest tuberculosis, regardless of the physical findings. If one takes roentgenograms of all who have symptoms of tuberculosis there will of course be many negative reports. There seems to be no way of avoiding this at present. On the other hand, the positive findings will confirm and elaborate our knowledge of the pathology in the cases which are easily diagnosed (those in Group I), and they will reveal cases which will be missed otherwise (those in Group III). It is the authors' view that the ideal way of handling patients would be to include a roentgenogram of the chest at the first visit. The best way of avoiding error seems to be to depend upon the symptoms found, and not on the physical examination, for guidance in selecting cases to be roentgenographed.

NOBLE, T. P., and HAUSER, E. D. W. Acute bone atrophy. *Arch. Surg.*, January, 1926, xii (Part 1), 75–94.

Further proof is offered of the existence of a type of acute bone atrophy which appears much more rapidly and is more extensive than that following disuse. Such atrophies may occur as a complication of injuries to the ankles or any joints, or a Colles' fracture. The results of treatment of such injuries are so uniformly good that one is likely to overlook the exceptional case in which convalescence is prolonged, and pain and stiffness of the hand or foot with atrophic changes persist for many months. Pain dominates the clinical picture, and the roentgenologic findings are very definite, and quite distinct from those of chronic bone atrophy.

This condition was first established as a definite clinical entity in 1900 by Sudeck, who clearly demonstrated the existence of two types of bone atrophy, the acute and the chronic, which differed very materially. Acute bone atrophy may occur in any part of the bony skeleton but appears to have a special predilection for the extremities and the spine. The clinical course of the disease falls into three distinct stages: (1) the initial injury; (2) the latent period, and (3) the period of the fully developed disease. The condition appears to occur in certain cases spontaneously with no history of injury whatever. The most common type of injury in the lower limb is a simple sprain, entirely ligamentous, without injury to the bone. The latent period is very definite, seems to vary according to the site, and is symptomless. Its duration is shortest in injuries of the upper extremity and longest in those of the spine. The clinical manifestations of the fully developed disease also vary according to the site. When this condition complicates a Colles' fracture the pain at the site of fracture is usually slow in subsiding, the swelling and edema of the hand persist, and the skin becomes glossy and slightly cyanotic. The changes in most cases are distal to the site of fracture, but in exceptional cases all the bones and joints of the arm may be

involved. If trauma is the etiologic factor the condition is usually unilateral, but in the spontaneous cases it is commonly bilateral.

In the lower limbs, acute bone atrophy is a very crippling disease and leads to prolonged incapacity unless treated early and vigorously. In the spine, the condition is still more serious; owing to the softening of the bones and the superimposed weight of the body, the vertebrae slowly collapse and a kyphos results which if not treated leads to involvement of the spinal cord and to spastic paralysis.

There are several theories as to the etiology of the disease but the condition seems best explained on the basis of a reflex trophoneurotic action. It seems probable that a reflex irritation and stimulation of the trophic nerves produce an excessive catabolism in the tissues.

The roentgenologic findings are definite and distinct. The acute phase passes through the chronic one on the way to recovery, but occasionally one finds that the condition has passed into the chronic phase before the patient comes for treatment. The apparent great predilection of this form of atrophy for the distal portions of the extremities is explained by Sudeck as due to the fact that the roentgen ray will show lesions easier in small bones than in larger ones. Bone atrophy is often missed in reading a roentgenogram, because there is no alteration in the form, only a diminution in density. The more distal the bones, the greater the atrophy.

The roentgen-ray appearances of the acute stage are characterized by perforations in the spongiosa producing irregular openings of various sizes. The lamellae are no longer clear cut, but fade into one another and produce a poorly defined shadow. This usually shows itself four to six weeks after the original etiologic factor has manifested itself, but the changes have been going on long before they can be demonstrated roentgenographically. There are scattered, irregular, rarefied areas like small, punched-out holes in the spongiosa of the distal joints and heads of the metacarpals or metatarsals, as the case may be.

In the chronic phase the rarefaction is greater than in the acute phase. The rarefied areas have disappeared; the spongiosa is widely meshed and the individual lamellae are thicker and stronger, but this increased strength is only in the longitudinal fibers, the horizontal ones remaining thin. If the atrophy continues the remnants of the spongiosa may be lost, giving an illumination, like that of a pane of glass.

During the years 1912 to 1924 forty-eight cases of acute bone atrophy have been recorded in the Mayo Clinic; 41 of these were in the lower limbs, 6 in the upper limbs and one in the spine.

Early and vigorous treatment will prevent disabilities and shorten the course of the disease. Four illustrative cases are cited.

PEIPER, HERBERT. Experience in the roentgen diagnosis of diseases of the spinal column and of the spinal cord with iodipin injection. *Deutsche med. Wchnschr*, Jan. 1, 1926, lii, 22–25.

A brief general review of myelography is presented. The direct roentgenological demonstration of meningeal or medullary tumors is a rarity. Almost equally rare are the so-called indirect signs, the secondary sharp pointed exostoses or scoliosis in the vertebrae adjacent to the tumor. The introduction of the myelographic method represents the greatest advance in the diagnosis of spinal cord compressions that has appeared in many years.

The author prefers the 40 per cent iodipin (Merck) to lipiodol. The new "lipiodol montant," an 8 per cent lipiodol, is objectionable for two reasons: it is low in contrasting power, and has a tendency to become arrested when ascending. The locality of choice for injection is that above a compression in the cisterna cerebellomedullaris. The method of lumbar injection followed by a Trendelenburg position is apt to introduce errors. The subsequent drainage of spinal fluid from the needle hole after a lumbar injection causes a diminution in the free spinal fluid and thereby retards the mobility of the oil. Deep cervical and dorsal punctures are also objectionable because of their danger. The cisternal puncture is, however, not without its hazards and should be done only by the experienced person. The maximum dose injected into the cistern is 2 c.c. More is unnecessary and dangerous. The membrane should be punctured at the first stab. Should there be several perforations the iodipin may sometimes escape through these, while being injected, and localized in the musculature of the neck.

The roentgenograms should be taken shortly after the injection, with the patient partly reclining, and should cover the whole spinal column. The method of roentgenographing with the patient in the standing position, which is preferred by the French, causes obscuring of many of the finer details owing to agglomeration of the oil. The ventrodorsal roentgenogram is capable of giving all the information desired. The elevated position of the patient should be maintained during the time necessary to obtain the required serial pictures. The roentgenoscopic examination

may be dispensed with and is considered no advantage where it causes loss of valuable time in the taking of roentgenograms.

Certain but not all forms of iodipin blockade may now be diagnosed as due to adhesive processes within the subarachnoid space. The myelographic determination of tumors is extraordinarily difficult and may now and then be impossible. The adhesive form of chronic meningitis may cause multiple arachnoidal contractions and thus prevent the free fall of iodipin completely or partly for days, weeks or even permanently just as is the case with tumors. A partial stoppage in which the oil is disseminated dropwise and shows a gradual channeling is suggestive of an adhesive process. The occurrence of sluggish channeling of a few individual drops of the iodipin is inconclusive, unless the neurological symptoms definitely indicate adhesive meningitis. This emphasizes the overshadowing importance of accurate neurological information in myelographic interpretation.

The injection of iodipin for discovering spinal tumors is justified only when the symptoms of cord compression point to the existence of a tumor which cannot be demonstrated by any other method. Since most spinal tumors are easily recognizable in the roentgenogram as metastases, the author disagrees with the French and considers myelography under such conditions superfluous. The majority of intraspinal tumors may be classified into three types according to the arrest of the iodipin: Type I, total permanent stoppage of the iodipin at the upper pole of the tumor; Type II, the major portion of the oil remains at the upper pole of the tumor, while a little drops below or disposes itself wholly or partly along the sides of the tumor; Type III, the iodipin behaves as in Types I and II and after twenty-four hours is found practically completely in the lumbosacral cul-de-sac. The type of passage of the iodipin at the tumor gives no information regarding its extra- or intramedullary localization.

Myelography is contraindicated in cases of Pott's disease and spina bifida. It is only in cases of uncertain differential diagnosis between Pott's disease and tumor of the spinal medulla that myelography is permissible, although it can show no more than the exact level of the site of compression and can give no information as to the actual diagnosis. A very promising field for the employment of myelography is in cases of spinal fractures with injury to the cord.

As regards the question of specific injury with the iodized oil employed in myelography, there seems to be sufficient evidence on which to base a tentative opinion. The procedure is never to be regarded as harmless. The clinical symptoms of irritation that have appeared in about half of the cases can be tolerated. They endure for four to five days and consist of more or less strong spinal root pains, increase in temperature, and headache; these symptoms are not so intense as for instance in ventriculography. The mortality following the use of iodipin has been zero up to date. The oil is reabsorbed extremely slowly and two years or more may be required for its disappearance. If the dosage of iodized oil is kept low, as recommended, no notable histological injuries will be produced in the human spinal cord. The greatest danger of myelography lies in its possible practice by unskilled workers.

RACHWALSKY, ERNST. Roentgenologic demonstration of the gall-bladder with oral administration of the contrast material. *Klin. Wchnschr.*, Jan. 8, 1926, v, 66.

The author employed tetraiodophenolphthalein in the form of pills containing 0.3 gm. of the dye mixed with paraffin and covered with various fats of low melting point (38.5 to 39°C.). These pills are assumed to pass through the stomach and the first portion of the duodenum without being dissolved and without exciting the vomit reflex.

The patients are instructed not to eat meat on the previous evening and to take 6 to 10 of the pills along with some bread. The next morning before roentgenization, the patient receives a cleansing enema and the examination is then made in the prone position upon a Bucky diaphragm using the tube without compression. The best roentgenograms were obtained twelve to sixteen hours after consumption of the contrast material.

RICHTER, HELMUTH. The technique and results of occipito-frontal roentgenography of the skull for the diagnosis of the accessory sinuses, especially inflammation of the ethmoid cells. *München. med. Wchnschr.*, June 4, 1926, lxxiii, 941–942.

The occipito-frontal roentgenogram is taken with the patient in a sitting position whenever possible, and use is made of a combined head and cassette holder. The nose and forehead are brought against the cassette and the head is fixed lightly with the holder. The roentgen tube is adjusted so that its cone (15 cm. long by 12 cm. diameter) touches the occiput. The central ray is visualized laterally by means of a metal rod and from above by means of a filament in the tube holder. The patient is then cautioned not to move. The

tube is operated at about 28 ma., the rays being of medium hardness. The time of illumination is important and should be considered in relation to the age of the patient, the shape of the skull, variations in primary current, use of intensifying screens and photographic material. In adults the average time of exposure was 2 to 2.5 sec.

The interpretation of the findings is entirely empirical. It can be made best from dried films with the aid of normal roentgenogram for comparison, and especially under guidance of the clinical findings. The degree of accuracy in the interpretation of these roentgenograms is exceedingly high. Amongst 343 cases mostly with diseases of the ethmoid, 313 were confirmed by clinical and operative findings. There was a positive finding in 282 cases and negative in 31. In the 18 cases of failure the roentgenological finding indicated some condition of the ethmoid which could not be confirmed clinically, and there were 10 cases in which the roentgenogram showed a pathological condition in the antrum of Highmore which the clinical finding failed to confirm. There were only 2 cases, one of the ethmoid and one of the antrum which gave definitely positive clinical findings and which were negative in the roentgenogram.

Conditions of the antrum are difficult to diagnose from the occipito-frontal roentgenogram.

It is clear that despite its limitations, the roentgenographic diagnosis of diseases of the ethmoid cells is remarkably accurate. Agreement with the other clinical findings was obtained in over 91 per cent of the cases examined. This result was obtained in the hands of an experienced personnel aware of the limitations of the procedure.

ROCHLIN, D. G., and SCHIRMUNSKY, KLAUDIA. The roentgenographic examination of arthropathia psoriatica. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 955–961.

Examination of 18 cases of psoriasis failed to demonstrate any clinical signs of arthritic involvement; yet a roentgenographic study showed in 7 cases arthropathic changes, namely: narrowing of the joint spaces, bone erosion and roughening of surfaces (especially at the distal ends of the middle phalanges). However the variety of joint conditions cannot serve as a proof of the arthritic origin of the psoriasis. The authors believe that the relationship between skin and joint conditions is not that of cause and effect. These represent merely coexistent conditions.

The cases all showed a peculiarly uniform constitutional picture. The hypophysis in these individuals was always found to be at the upper limits of the norm. The hand skeleton was of acromegaloid type. Abnormal activity of the various endocrine glands was observed fairly often. As regards the joint affections in these cases, they were all polyarticular and symmetrical. Gout, rheumatism and gonorrhea were excluded in all of them.

SUTHERLAND, CHARLES G. Cholecystitis with stone producing an atypical shadow: Report of a case. *Radiology*, February, 1926, vi, 161–162.

A case is reported in a woman aged forty-eight who had suffered for fourteen years from a sensation of pressure over the gall-bladder area. There was never any jaundice, nausea or emesis. During the week preceding examination she had suffered daily attacks of cramps in the upper abdomen. A roentgenogram revealed a large calcified area on the right side at the level of the first lumbar vertebra, and below the shadow of this a second crescent-shaped shadow apparently associated with the upper one. A cholecystogram showed the absence of dye, and the shadow was similar to that in the roentgenogram. Urologic examination failed to show any involvement of the urinary tract. The pelvis was shown in the pyelogram to be elongated and displaced outward and toward the median line, apparently as the result of pressure from the extrarenal mass. The clinical diagnosis was cholecystitis with stone and calcification of the gall-bladder wall. An exploratory operation showed the gall-bladder to be greatly distended and filled with a white grumous material, chiefly cholesterol. The wall of the gall-bladder was rigid and calcareous and there was one stone $4 \times 2.5 \times 2$ cm. Inspection of the gall-bladder after removal gave the impression that the crescent-shaped shadow resulted more from the thickened coating of the wall of the gall-bladder than from calcification in the wall.

THOMA, KURT H. A review of our present knowledge of the pathology and roentgen diagnosis of periapical tooth infection. *Boston M. & S. J.*, Apr. 29, 1926, cxciv, 768–769.

The great variation in appearance of periapical tooth infection in the roentgenogram furnishes opportunity for many differences in diagnosis and great diversity of opinion. A review is therefore given of certain phases of the pathology of these infections and how they cause changes that can be recognized roentgenographically.

The development of these infections depends upon two principal factors: (1) the nature of

the local injury, and (2) the systemic defense factor. It should be kept in mind that the anatomical location of the abscess cavity has a great deal to do with the varying appearance in the roentgenogram. The involvement and perforation of the cortex of the maxilla or mandible gives a much more clearly outlined area on the film than a lesion confined to the central part of the bone. The content of the abscess cavity has little influence on the radiopacity of the lesion; whether it contains a granuloma, pus or serum will not alter the picture greatly; it is the amount of bone destruction that is shown. In this connection, the relation of the teeth to the maxillary sinuses should be remembered. The amount of bone destruction is limited by the natural anatomical variations.

Where there is an infection in which the individual shows little or no active defense against the infection, the roentgen picture will only show very small bone defects, and very often, increased density of the bone and enlargement of the apex of the root. We now recognize that pulpless teeth which roentgenographically show but little evidence of bone destruction at the apex may be serious sources of disease in patients who have a natural or an acquired susceptibility to streptococcal infections. Where the individual evidences an active defense, there is no reason why pulpless teeth with normal periapical tissue may not be retained, especially if the patient is seen regularly and if the teeth are roentgenographed periodically.

The roentgenographic method will not directly demonstrate pulp infection, but it will show indirect evidence such as a causative factor (caries under filling, crown, etc.) or a resulting reaction in the peridental membrane (infiltration of leucocytes and lymphocytes) with enlargement of the spaces between the root end and the bone. This condition should be carefully sought when making a roentgenographic study of the teeth. It appears as a crescent-shaped area around the apex.

It is emphasized that a roentgen examination alone is not sufficient for a diagnosis of dental conditions. The physical condition of the patient and his susceptibility to streptococcal infection should be looked into.

ABEL, A. LAWRENCE. The treatment of cancer of the esophagus. *Brit. J. Surg.*, July, 1926, xiv, 131–159.

Cancer of the esophagus gives early symptoms and remains localized to the affected organ long after its presence can be definitely diagnosed. Moreover glandular metastases from carcinoma of the esophagus are the exception rather than the rule and the majority of sufferers from this complaint do not die from carcinoma but from starvation. Consequently this type of cancer is and almost always should be diagnosed at a very early date. It is the author's opinion that the only adequate form of treatment is surgical removal. Complete freedom from local recurrence should follow the operation, and late glandular recurrence should occur only in a minority of the cases. The details of the various types of operation are given. Radium, roentgen rays and diathermy are of very little value in the treatment of the disease except where palliation is intended.

The diagnosis can be easily established in the physical examination. Roentgenoscopy in the oblique position is preferred to roentgenography as a means of securing the necessary information. Even when no stenosis is present the roentgenogram may show retention of a small portion of the opaque substance at the site of an early lesion. If only slight stenosis is present no arrest of contrast fluid is seen, bue a slight diminution in the caliber of the tubt may be indicated. In the typical picture the barium passes through a malignant stricture and shows an irregularity at its lower extremity (rat tail like appearance). If it is proposed to treat the case with radium, it is essential that the total length of the malignant stricture be accurately determined. For this purpose retrograde roentgenography is employed This is done by placing the patient in a slight Trendelenburg position, and the roentgenogram is taken while he is swallowing a fairly thick mixture of the contrast material; or it may be sufficient to have the patient lying horizontally with the right shoulder on the table and the negative placed against the posterior part of the left shoulder.

Esophagoscopy is of extreme importance especially in the earlier stages of the disease in order to establish an accurate diagnosis. In skilled hands this procedure is almost devoid of danger.

ABERCROMBIE, G. F. Radiography in a case of triplet pregnancy. *Proc. Roy. Soc. Med., Lond.*, April, 1926, xix, Sect. Obstet. & Gynaec., 58–60.

Triplets have been demonstrated *in utero* roentgenographically on four previous occasions. The present case report is an admirable example of the great value of roentgen rays in antenatal work. At a comparatively early stage of pregnancy when all other diagnostic methods failed, the roentgen rays gave accurate information of the position and of the number of fetuses present. The roentgenogram in the present case disclosed two fetal spines in

the right hypochondriac region; the upper of these was continuous with the head in the left hypochondrium and the lower with the head in the left iliac fossa. Immediately below the shadow of the head in the right iliac fossa could be seen the rather faint indication of the third fetal spine. This examination was made at about the twenty-eighth to thirtieth week of gestation.

ANDREI, ORESTE. To what extent is it possible to tell the age of a fracture from the roentgen picture? *Chir. d. org. di movimento*, February, 1926, x, 255–293.

This question came up in connection with a medico-legal case in which a man claimed damages for a fracture sustained in an injury. Roentgen examination showed a healed fracture that must have dated from a time long before the accident. As a result of this incident Andrei made a study of a large number of cases of fracture and presents brief notes of them together with roentgenograms at different stages. He concludes that in simple fractures of the diaphysis without displacement of the fragments the first change that can be seen is a blunting of the edges and angles of the broken bone, which becomes visible at the end of the second week. The callus begins to appear between the sixteenth and twentieth days after the trauma; it is clearly defined from the third to the fourth month and regains the opacity of normal bone between the eighth and tenth months after the trauma. Within the first year after the fracture the bone does not have a lamellar structure. Reconstruction of the system of lamellae begins in the thirteenth to fourteenth month and is well advanced at the end of the second year. The fracture line disappears between the sixth and eighth month after the trauma but later becomes evident again as a line of greater opacity in the bone. At the end of the second year, although the callus is greatly reduced, a trace of it can still be seen in the form of a thin and very opaque layer in the compact tissue of the bone.

In fractures of the diaphysis with displacement of the fragments the blunting of the margins and angles appears at the end of the second week and the callus becomes visible in the third or fourth week. It becomes demarcated from the neighboring tissues later than in the other fractures, that is during the sixth or seventh months, and at the same time takes on the opacity of normal bone. It is not absorbed so well as in fractures that have been well reduced and a definite time for the reconstruction of normal bone structure cannot be set.

In fractures of the phalanges, metacarpals and metatarsals there is a blunting of the margins and angles of the bone at the end of the first week. Within a little while afterwards, generally at the end of the third week and sometimes as early as the beginning of the second, the callus appears in the form of a delicate white cloud. At the end of the fourth month it is clearly defined and toward the sixth or seventh month it has the opacity of normal bone. During the first year the bone does not have a lamellar structure; this structure appears in the thirteenth or fourteenth month and is more or less advanced at the end of the second year. The fracture line disappears between the sixth and eighth month but becomes evident again later as a bone cicatrix.

BÉCLÈRE, HENRI, and PORCHER, PIERRE. Lateral roentgenography of the hip. *J. de radiol. et d'électrol., Par.*, March, 1926, x, 97–105.

Frontal roentgenography often does not give all the necessary detail in regard to the neck of the femur and the relations of the head to the acetabulum. Seven positions for taking a lateral roentgenogram are described and illustrated, each of which has its advantages under certain conditions. The first is Arcelin's position in which the patient lies on his back with the normal hip flexed 90° on the trunk; the film is applied to the external border of the hip to be examined, the dorsal ray passing in front of the perineum, the edge of the localizer being in contact with the inner surface of the thigh to be examined and with the intergluteal fold. The second is Coste's position which gives a very complete lateral view of the neck of the femur. The patient lies on his back and the film is placed between his thighs, being pushed up as far as possible toward the perineum; the normal ray passes parallel to the plane of the table, a little above the wing of the ilium. The ischium and hip are brought out more or less clearly depending on its obliquity with relation to the axis of the thigh. The third position is that used by Lilienfeld for getting a profile picture of the neck of the femur. The patient lies on his right side if the right hip is to be examined. He is turned slightly toward a position of abdominal decubitus and the tube centered as if a profile of the coccyx were to be taken. The obliquity of the latter brings it in front of the picture of the neck and an almost exact image of the neck of the femur is obtained, shortened a little more than in Arcelin's position. The fourth position is one worked out by the authors in collaboration with Henry in trying to determine the best position for getting a roentgenogram of the urethra; they found that by placing the patient in lateral decubitus they could get a clear picture of the head and

neck of the femur lying on the film, free of other shadows. The patient lies on the hip to be examined which is flexed a little forward; the other hip is extended and the tube is centered so that the central ray falls on the skin at the middle of the inguinal fold of the side opposite the one to be examined. In position 5 they tried to get a profile of the neck of the femur with the patient in dorsal decubitus; the film is applied to the external edge of the hip to be examined, the normal ray passing above the wing of the ilium of the opposite side. In position 6 they used the arched film, a method of their own described in Marchand's thesis; the patient is placed in abdominal decubitus, the hip of the side to be examined falling beside the table and the film passing over the edge of the table under it; the normal ray is directed toward the greater trochanter and falls as perpendicularly as possible on the middle of the curvature of the film. In position 7 the patient lies on his back with the hip in forced abduction and external rotation. The image is very clearly dissociated from all other shadows but it is not an exact profile; nevertheless it gives valuable information in regard to the inner surface of the greater trochanter.

Of course some of these positions are very hard for a patient to assume if he is suffering from a trauma or a congenital or acquired disease which wholly or partially immobilizes the hip. The position to be used should be determined in each case. Position 5 is the one that can be assumed with the least inconvenience to the patient.

Bonnamour, Badolle and Beaupère. The roentgen picture of the thoracic aorta. *J. de radiol. et d'électrol., Par.*, February, 1926, x, 69–77.

Normally the thoracic aorta is not visible in the roentgenogram. The posterior mediastinum is represented by a clear space not crossed by any vessel shadow. But Vaquez and Bordet report that after sixty years of age visibility of the thoracic aorta, even throughout its length, is the rule and cannot be regarded as pathological. They give three degrees of visibility; 1st degree, the arch, which normally is covered by the left border of the sternum, can be seen; this can be seen in a frontal view. In the right, or still better the left, oblique position, the horizontal aorta can be seen, but it does not reach to the spinal column; 2d degree, the horizontal aorta can be seen in the oblique position reaching to the spinal column and also the beginning of the descending part down to the hilus; 3d degree, the whole of the descending aorta is visible down to the diaphragm.

The authors have examined a large number of normal adults and old people in the Red Cross Hospital and do not find these statements completely confirmed. They do find the first degree of visibility practically constant in subjects over sixty years of age but the second and third degrees are much less frequent. The 1st degree of visibility they think is due to a tortuous aorta with a higher arch than normal. But they find the second degree much less frequently and the third practically never.

It will require further study to determine the cause of this opacity of the thoracic aorta. Atheroma and deposits of cholesterin and calcium in the wall of the aorta are not sufficient to explain it for they are not present in many old men and they may be found in comparatively young subjects, thirty-five to forty-five years of age. The opacity may be caused by syphilitic sclerosis of the wall of the artery; there are some cases which seem to indicate that this is true but it has by no means been demonstrated for all.

Bonnamour, Badolle and Beaupère. Roentgen diagnosis of gas cysts of the intestine. *J. de radiol. et d'électrol., Par.*, April, 1926, x, 164–168.

Cystic pneumatosis of the intestine is rare. Up to 1919 only 66 cases had been published. Clinical diagnosis is impossible but 6 cases are described showing that it is possible to make the diagnosis by roentgen examination. The patient is generally sent to the physician for an examination of the stomach, in the majority of cases for suspected ulcer, with clinical signs of stenosis of the pylorus. Before any contrast medium is taken the picture of the abdomen is almost that of a pneumoperitoneum, with apparent ptosis of the liver which is separated from the diaphragm by a large clear band. Sometimes there is also ptosis of the spleen. Generally the diagnosis of stenosis of the pylorus is confirmed. The only thing to eliminate in differential diagnosis is ectopy of the colon with interposition between the liver and the diaphragm. Several cases of this have been described. But often the valves and falciform folds of the mucous membrane of the colon can be seen, while gas cysts show uniform clearness or a lobulated, mulberry form, with paritions closer together than those of the large intestine. Operation should always be recommended, in the first place because of the stenosis of the pylorus and in the second because experience has shown that after laparotomy these patients recover without the intestine having been touched. After operation roentgenocopy shows that the pseudoptosis of the liver and the

abnormal clearness of the abdomen have completely disappeared.

BRAILSFORD, J. F. The *x*-ray diagnosis of animal parasites (helminthes) in man. *Proc. Roy. Soc. Med., Lond.*, August, 1926, xix, Sect. Electro-Therap., 41–52.

The chief parasitic conditions detected by roentgen rays are echinococcal cysts and the cysts of *Cysticercus cellulosae*, but the roentgen appearance of conditions such as calcified trichinae, *Paragonimus westermanii*, onchocerci, *Ascaris lumbricoides* and *Bilbarzia* have been described. The possibility of roentgen diagnosis depends on the calcification of the parasites or their location in the body.

Most of the encysted embryos undergo calcification. The roentgenogram is not of much value in the early days of infestation unless the parasite is situated in the lung fields. The presence of calcified parasites does not exclude the presence of living parasites. When the parasite is located in the lung, as in echinococcal cyst, their relative density permits of an early diagnosis. In bone where active absorption takes place with the development of the parasite the roentgenogram will detect changes in the early stages, but the diagnosis will not be easy.

The appearance of abnormal shadows of rounded or irregular structure with evidence of partial or complete calcification should lead one to consider hydatid cysts in the differential diagnosis. When completely calcified the shadows are denser than those of bone. The spherical calcified cysts frequently contain daughter cysts and solices. It is usually the cysts located in the lung field which are diagnosed by the roentgen ray. These are often found as the result of a roentgenoscopic examination of a patient who has had hemoptysis and in whom tuberculosis is suspected; but they may be detected quite accidentally while roentgenoscoping a patient who has given no sign of pulmonary disease. In the latter case the cysts appear as isolated spherical shadows of uniform density with sharp regular borders, varying in size from that of a pea to that of a large orange, surrounded by normal lung tissue. With such a picture there is no other pathological condition for which they could be mistaken. Wherever the cyst is located it tends to assume a spherical appearance, a feature which should help one to distinguish it from localized abscesses or fluid collections. Cysts in the liver and other abdominal organs may be demonstrated by the pneumoperitoneal method. When they are localized in the liver one may see a raising of one side of the diaphragm; or a local spherical protuberance may be visible through the right lung base. In the bone the cysts present the appearance on the roentgenogram not unlike that of a myeloid sarcoma. The first evidence of this pressure may be the spontaneous fracture of the bone involved.

Cysticercus cellulosae. The most likely way in which the presence of *Cysticercus cellulosae* may be missed is in attributing the shadows of the parasites on the roentgenograms to defects in the film, caused by spots of water being spashed on the drying film. In fact, the dried spots of water often seen on films resemble the size and shape of cysticerci. This error is not likely to be committed if the cysts are very numerous as in the films of the thigh and leg, but this would be possible in the case of the roentgenogram of the pelvis in which only a few cysts are present. The cysts are shown as oval bodies of uniform size, 4 mm. × 8 mm., lying in the direction of the muscle fibers.

Trichina spiralis. Roentgenographically these parasites have been chiefly demonstrated in portions of muscle removed at post mortem. The individual cysts vary from 0.1 to 1.0 mm., and in the roentgenogram they give the musculature the appearance of having been dusted with meal. Systematic roentgenography of the upper arm has been recommended for the detection of these cysts, but the author recommends roentgenographic study of a dental film of part of the masseter because of the preference of the parasite for the muscles of mastication and because its occurrence in great numbers would tend to hide the existence of the parasite in a thick part. It should be remembered that if infestation is in the acute stage, before calcification of the cysts has occurred, the roentgenogram will not disclose very much.

Ascaris lumbricoides has been demonstrated in 2 cases by Fritz, the worms being seen in the opaque meal. *Bilbarzia* is probably the only other common helminth which may produce some roentgenographic signs. In some cases of this disease calcification of the bladder and ureter wall takes place.

Köhler has demonstrated the roentgenographic appearance of infestation of the lung with *Paragonimus westermanii*.

BUONSANTI, PAOLO. The influence of surgical diseases on the development of the centers of ossification. *Chir. d. org. d. movimento*, December, 1925, x, 61–82.

In order to study the effect of various surgical diseases on the development of the bones the author made roentgenograms of the carpus in normal individuals and in patients with various surgical diseases, including tuberculosis of glands and of bones other than those of the

carpus, acute inflammatory diseases, constitutional diseases, tumors and congenital and acquired deformities. The roentgenograms show that even in normal individuals there is great variability in the time at which the centers of ossification of the bones of the carpus appear. The time of their appearance varies as much as one to three years. They appear earlier in girls than in boys.

The various diseases studied did not appear to have any effect on the time of development of the centers, not even in a case of chronic suppuration from osteomyelitis in which the general condition was seriously affected. Apparently surgical diseases do not affect the organs which stimulate growth of bone. The practical surgical application of this fact is that the surgeon may prolong repeated bandaging and immobilizing treatment in diseases which require it, such as tuberculosis of bones and various orthopedic conditions, without any fear of damaging the development of the centers of ossification.

Burrell, L. S. T. The diagnosis and treatment of intrathoracic new growths. *Lancet, Lond.*, Feb. 27, 1926, i, 435–436.

No time should be lost in confirming the diagnosis of intrathoracic new growths; and when once it is confirmed the surgeon should be called in and time should not be wasted in trying radium or any other form of treatment. It is emphasized that non-malignant growths such as a dermoid or fibroma often prove fatal if ignored too long. The roentgen rays in the diagnosis of these conditions are very valuable. The injection of lipiodol or the induction of a pneumothorax may assist considerably in the roentgenographic diagnosis.

In the author's experience, roentgen therapy is very good in cases of lymphadenoma and sarcoma and should always be used. For other forms of intrathoracic growth, roentgen-ray and radium therapy were found disappointing; but they should be tried in cases which are inoperable. When operation is possible, it should be tried first. Syphilis must be carefully excluded before a final diagnosis is established.

Bustos, Fernando M. Sacralization of the fifth lumbar vertebra. *Semana med., Buenos Aires*, Jan. 21, 1926, xxxiii, 144–154.

This condition was first described in 1888 but it has only recently been found to be the cause of some painful conditions which have heretofore been diagnosed as sciatica or lumbalgia. In the first degree of the affection there is only increase in size of one or both transverse processes of the fifth lumbar vertebra; in the second they are increased until they come in contact with the sacrum, but there is no joint formed; in the third the process is very large and is connected with the wing of the sacrum by a true joint, in the fourth the process enters into relation with both the sacrum and the ilium; in the fifth there is a true synostosis between the transverse process and the sacrum, and in the sixth the synostosis includes the body of the vertebra also and may be called a complete sacralization. Most authors say that there must be contact with the sacrum to constitute sacralization and that the first degree given above should therefore not be counted, but it sometimes causes the same painful syndrome as a true sacralization and may be called a pseudo-sacralization. Different degrees of sacralization may exist on the two sides. Anatomic sacralization sometimes exists without causing any symptoms.

The pain syndrome appears most frequently in men between twenty and forty years of age and is generally diagnosed as sciatica or lumbalgia. Physical examination often shows that the vertebral column has lost its normal lordosis and is straight; and there may be scoliosis of different degrees, crossed or homologous. Differential diagnosis from tuberculous spondylitis, spondylolisthesis and traumatic spondylitis may be made by roentgen examination. A valuable method of differentiation from sciaticas not caused by sacralization is to inject a local anesthetic to determine the segment from which the lesion originates. The roentgen picture may be confused in some cases by superimposed shadows. The fifth lumbar vertebra may be more or less wedged into the interiliac space and the shadows of the transverse processes, the highest part of the wing of the sacrum and the highest part of the ilium may be superimposed.

The condition is probably due to atavism. In examining the skeletons of anthropoid apes the author found that they have a symmetrical and bilateral fusion of the fifth lumbar with the sacrum, and in the South American natives there is often such a sacralization also.

There may be an infectious or traumatic element added to the sacralization in the causation of the pain syndrome and treatment for that should first be given. If medical and roentgen treatment are not effective, the transverse process or processes should be resected.

Dillingham, Frederick H., and McCafferty, Lawrence K. Bone syphilis. *Am. J. Syph.*, July, 1926, x, 373–382.

Three cases are reported; one of early periostitis, one of the thickening of the periosteum with osteoporosis of the bone cortex, and one

of extensive osteomyelitis with thickening of the bone cortex and elevation of the periosteum.

When syphilis of the bone exists for any length of time there is present not only periostitis but at the same time various phases of bone pathology such as sclerosis, rarefaction and osteomyelitis. It is only in the beginning of bone syphilis that one sees the wavy, irregular line of the periosteum in the roentgenogram, which almost always signifies syphilitic periostitis. This picture is seen so frequently, that sight may be lost of the fact that syphilis may also cause the other definite lesions mentioned above.

One should be on the lookout for syphilis at the first sign of nocturnal pain. One should not treat too lightly the "aches and pains" of middle life, but should attempt to assign a definite cause rather than to classify them all under neurasthenia, rheumatism, etc. A roentgenogram should always follow a negative Wassermann reaction in cases presenting persistent nocturnal pains whether or not the history is suggestive of syphilis. The roentgenologist may not be able always to definitely differentiate bone syphilis from tuberculosis and other diseases of bone, but he can frequently aid the syphilologist in arriving at a tentative diagnosis. At times it may be necessary to resort to the therapeutic test, but this is infrequent.

EADES, M. F. Postoperative massive atelectasis. *Boston M. & S. J.*, Aug. 5, 1926, cxcv, 258–263.

Postoperative massive atelectasis is a frequently unrecognized pulmonary complication. The diagnosis is important in order to eliminate more serious conditions with which it may be confused. The cardinal clinical sign is displacement of the heart toward the affected side. In the involvement of the right lung, the cardiac impulse is frequently found at the left border of the sternum. If the left lung is affected the cardiac impulse may be found on the left anterior or mid-axillary line. The position of the heart should be verified roentgenographically in all suspected cases. This is especially important in the recognition of cases in which the lung involvement and the cardiac displacement are slight. In extensive involvement the affected lung shows a remarkable degree of uniform density comparable in some instances to that of the cardiac shadow. In some cases a definite deviation of the trachea toward the affected side is also evident. The roentgenogram may be the only means of differentiating this condition from embolism or infarct, owing to the varying degrees of the clinical signs and symptoms.

It is believed that bronchial obstruction and weakened respiratory movement in varying combinations produce postoperative massive atelectasis. The prognosis in cases of unilateral collapse is excellent; in bilateral involvement the outcome is liable to be fatal. No treatment has been found which influences the course of the condition.

GIAUME, CESARE. The etiology and pathogenesis of achondroplasia. *Pediatria*, April, 1926, xxxiv, 359–369.

A child thirty months of age had had an abnormally large head and short limbs at birth. In the early months of his life his head continued to develop rapidly and he was given a mercurial treatment with good results. The child himself has a one plus Wassermann reaction, while the father's reaction was 2 plus and that of the mother 3 plus. Roentgen examination showed exaggerated development of the vault of the cranium as compared with the face and the base. The bones were very thin, especially in the fronto-parietal region. The fronto-parietal suture was more prominent than the others. Because of technical difficulties the picture of the base was not clear enough so that the structure of the sella turcica could be determined accurately. The diaphyses of all the bones of the limbs were shorter than normal. There was no marked abnormality in their structure. In the arms the proximal and distal ends of the diaphyses were clearly visible but the epiphyses were not visible. The distal extremity of the ulna did not reach to the wrist joint. The radius was curved; the 4th metacarpal was shortened. In the legs the upper and lower ends of the diaphyses were clearly visible, but they were pointed. The distal and proximal epiphyses of the tibia were visible; the articular cartilages were somewhat smaller than normal; slight dorso-lumbar kyphosis and lumbar lordosis with marked forward inclination of the pelvis. No apparent change in the structure of the vertebrae. The lower limbs were 12 cm. shorter than normal while the arms were shortened only 1.5 cm. The proportion between the tibia and femur was almost normal while the radius was longer than normal in proportion to the humerus.

In addition to the classical signs of achondroplasia there were also some signs indicating rickets, such as the macrocephalia and the ogival form of the palate; also the enlargement of the thorax at the base and the costal rosary. But fetal dystrophy may extend to the bones of the trunk also. Possibly the two diseases coexisted in this case.

The syphilis was undoubtedly the cause of the disease in this case, though it may be

produced by any toxi-infection acting on the fetus between the 4th and 6th weeks of development.

GIORDANO, D. Aneurysm of the abdominal aorta with gastric symptoms. Introduction of silver-plated wire into the sac of the aneurysm. *Ann. ital. d. chir.*, 1926, v, 125.

A man of forty-nine was sent to the hospital Dec. 13, 1923, for suspected tumor of the lesser curvature of the stomach. Fifteen years before he had contracted syphilis, for which calomel injections were given for a month, when he withdrew from treatment as he felt well. About seven years ago he began to have burning pain in the stomach, beginning about two hours after meals and lasting for an hour or two. Two years ago he lost 2 kilograms in weight and in addition to the burning sensation a feeling of weight in the epigastrium developed after meals, with pain lasting for one or two hours; acid eructation, constipation. For the past five months he had had epigastric pain radiating to the back. Roentgenoscopy showed a large defect in the lesser curvature which was assumed to be due to tumor. On examination he was found poorly nourished, with a clavey pallor and fetid breath from dental caries. Abdomen rather rigid with pain in the epigastric region, most intense in the midline beneath the ensiform process. The rigidity of the muscles made examination difficult but a tumor could be felt with an arterial pulsation which was thought to be transmitted. Roentgenographic examination showed the stomach large with a tendency to hypotonia; there was deformity of the shadow of the pylorus and antrum where pressure was painful.

Epigastric incision showed a pulsating retrogastric tumor the size of a fist, very evidently an aneurysm of the subdiaphragmatic aorta. A small copper wire plated with silver was passed into the aneurysm through a large syringe needle; 30 cm. of the wire was used. It was kept coiled, and coiled again in the aneurysm. Five c.c. coagulen was injected into the tissue around the aneurysm and the bleeding stopped. Uneventful recovery followed by intravenous injection of an arsenobenzol compound and intramuscular injection of calomel. A month after the operation roentgen examination showed that the end of the wire had uncoiled and risen in the aorta from the level of the 2d lumbar vertebra to the level of the 7th dorsal. Another examination after fifteen days showed the wire in the same position, and a semilunar segment of the lower and anterior part of the aneurysm appeared more opaque, as if from stratified clots adherent to the wall. As the patient felt well and was relieved of all his gastric symptoms he left the hospital and refused to return for further injections.

He was brought back May 12, 1925, by one of the nurses who was interested in the case. He had put on weight, his color was good and he felt well. Epigastric palpation still showed pulsation from behind forward, but no lateral expansion. Roentgenoscopic examination showed no expansion of the tumor. Roentgenographic examination showed that the upper part of the wire had broken off and risen in the aorta, where it curved with the arch.

It is hard to say whether the improvement in this case was due to the introduction of the wire into the aneurysm or to the antisyphilitic treatment, but as it began immediately after the operation the author thinks it was due partly at least to that. The presence of the broken wire in the aorta is a cause for serious anxiety.

A recent article in the *British Journal of Surgery* reviews 3 similar operations; one of the patients died eight and a half months after the operation, the others within a few days. The authors advise gastroenterostomy after the insertion of the wire into an aneurysm for fear of acute dilatation of the stomach from pressure on the pyloric or prepyloric region. But in this case the operation not only did not cause any stomach symptoms but relieved those which already existed. It is hard to say whether this relief was due to the decreased expansion of the aneurysmal sac or to the section of sympathetic fibers in exposing the sac above the lesser curvature.

GUILLEMIN, A. Roentgenoscopic diagnosis of gastrointestinal perforations: spontaneous pneumoperitoneum. *Arch. franco-belges de chir.*, August, 1925, xxviii, 684–702.

Sometimes the symptoms of a gastrointestinal perforation are so indefinite that diagnosis is difficult. Even as expert a gastrointestinal surgeon as Moynihan made an incision in the right iliac fossa in 18 out of 49 cases on a mistaken diagnosis of appendicitis. Guillemin describes 2 cases, one of violent abdominal pain in pneumonia and one of ruptured tubal pregnancy in which the symptoms were those of perforated gastroduodenal ulcer, and on the other hand, one in which the symptoms of a real perforation were so slight that the diagnosis was not made and the patient died.

In 1916 Lenk first used roentgen examination to diagnose perforations of the intestinal tract by bullets. He demonstrated a spontaneous pneumoperitoneum; the intestinal gas had accumulated between the liver and diaphragm which were pushed apart. A number of other

authors have since used it in perforation of gastroduodenal ulcers and typhoid perforations of the intestine. Vaughan and Brams demonstrated free air in the peritoneal cavity in 13 out of 15, or 86.7 per cent of cases of typhoid perforation.

The author has made a systematic examination of all the patients who entered his hospital with signs of gastrointestinal perforation during the past year. He was able to make a diagnosis of perforation in 7 cases, 4 of perforation of gastroduodenal ulcer, 2 of perforated appendicitis and one of bullet wound. The tendency of the gas is to rise to the highest point so that if the perforation is above the mesocolon the gas will rise and collect between the liver and the right side of the diaphragm; the diaphragm will be immobile. But if the perforation is below the mesocolon the gas will strike the barrier of the omentum and transverse mesocolon and push them up. In low or appendicular perforation the gas may pass along the colon and accumulate under the diaphragm. If there are adhesions the gas may be encysted locally.

The method is a valuable aid in cases which are doubtful clinically. Its value is not absolute for a small accumulation of gas in a case with early adhesions may not be seen; but in that case, the perforation being covered, there is no great danger to the patient. In perforated gangrenous appendicitis there may be a question as to whether the gas is from a perforation or has been produced by anaerobic bacteria. The objection has been urged that it delays operation and that the patient may be injured by the change of position necessary for the examination. But an early diagnosis is a necessary preliminary to early operation and the making of an exact diagnosis by means of roentgenoscopy may hasten, rather than delay operation. The patient can be examined in a semi-reclining position and there is very little danger of breaking adhesions or of disseminating the infection.

HEUSER, CARLOS. Air in the bladder. Roentgenographic explanation of how it may cause death. *Semana med., Buenos Aires*, Jan. 28, 1926, xxxiii, 214–217.

So far the author has not had a case of death from insufflation of air into the bladder but he has had a case which explains how it may occur. He injected air in a case of suspected tumor of the bladder in which cystoscopy could not be performed on account of stricture. Some of the air escaped between the sound and the urethra and none could be seen in the bladder. A second insufflation was made and 30 c.c. lipiodol also injected. The latter could be seen in the bladder but no air. Another roentgenogram was taken including the kidney region and the ureters and kidney pelves were found distended with air to such an extent that the ureters looked like small intestine but were recognized as ureters from their position. If a little more air had been injected they would have ruptured. In a case like this if the walls of urinary canals were fragile air would infiltrate into the circulation and death result from embolism of the heart. Not more than 80 c.c. of air should be insufflated into the bladder. There are probably many cases of reflux of air into the kidney but many of them have not been recognized because the air was thought to be in the intestine.

ICKERT. Sectional roentgenography. *Beitr. z. klin. Tuberk.*, 1925, lxiii, 216–220.

In the ordinary lung roentgenogram, the central ray is usually directed to the spinous process of the fourth or fifth thoracic vertebra, and as a result, the lower lung fields where bronchiectases are mostly located receive only the peripheral, obliquely directed rays. Since it is difficult to photograph the whole lung with parallel rays, this being possible for only small sections, the author resorts to the roentgenography of only small sections of the lung, and terms it "sectional roentgenography."

For this purpose small plates 9×12 cm. or 13×18 cm. are employed. The particular field is roentgenoscoped and when the desired area is localized, the plate is introduced and exposed. The incident roentgen rays are cut down by a metal diaphragm so that only the required field is covered.

This procedure permits a much better study of sections of the lung in which unusual conditions are present, and has the advantage that the smaller plates are less expensive than the large chest plates. With the aid of iodipin, bronchiectases are clearly outlined and localized by the method of sectional roentgenography. The relations of the cavity to the surrounding structures are brought out clearly, and their relations to pleuritic adhesions are indicated better than in the customary chest roentgenogram.

ICKERT. On isolated calcified foci in the adult. *Beitr. z. klin. Tuberk.*, 1926, lxiii, 483–496.

From studies on lungs of cadavers, it was determined that the roentgenoscopic method is far more valuable than the roentgenographic in the diagnosis of shadows of calcified foci. An examination of 1336 persons seen by the author in 1925 disclosed 779 (58.3 per cent) as having calcified foci. These shadows are much more easily and frequently found when one is on the lookout for them than otherwise.

These calcifications appear to be somewhat more frequent in women than in men, the ratio being 108 to 100.

The study was made on individuals over fourteen years of age. The relative number of persons with calcified foci was found to be increased between the second and third decades of life, the increase being from about 50 to 60 per cent.

Among the 1336 persons, there were 29.2 per cent characterized as tuberculous, and of these 58.6 per cent showed calcified foci. Among the "non-tuberculous" the percentage with calcifications was 55.8. Among those cases showing calcified foci, there were 29.1 per cent who were tuberculous; and among those not showing any calcified foci 29 per cent were tuberculous. This would seem to indicate that calcified foci represent neither a special protection nor an unusual hazard as regards subsequent infection with tuberculosis. There were multiple calcified shadows in 28.2 per cent of the cases; 28.5 per cent of the non-tuberculous and 27.6 per cent of the tuberculous individuals showed multiple calcifications. Of the cases with multiple shadows 29.2 per cent were tuberculosis and of those with solitary shadows 29.3 per cent. This therefore woud indicate that the presence of multiple calcified foci appears to have no effect on subsequent tuberculous infection. One of the striking observations is the fact that the relative number of cases with multiple calcifications increases with age at first, but begins to decrease in the older age periods.

With only a very few exceptions, the shadows seen actually represent calcified foci of either primary or subsequent infections. Pathologic, anatomical and roentgenological considerations would seem to indicate that a good many of these foci represent aerogenic infections.

The right lung seemed to be the site of these calcifications more often than the left, and their distribution in the various lung fields corresponded roughly to their volumes. Apical foci and apical processes were observed only rarely in this series of cases in patients over forty.

KLARE, K., and REUSSE, P. The bronchiectases of childhood. *Beitr. z. klin. Tuberk.*, 1926, lxiii, 255–267.

Chronic bronchiectasis is a relatively frequent disease picture in childhood. This conclusion is the result of observations during the past five years upon 85 children, some with definite bronchiectasis and others with only slight affections of the respiratory organs assumed to be early stages of bronchial enlargements.

There is nothing in the general physical examination of most of the children that is considered of particular note. There is frequently present in association with early bronchiectasis a bronchitis which responds fairly well to the usual hydrotherapeutic treatment. The clinical findings vary considerably according to the extent and stage of the disease, the presence of coughing and expectoration. One may frequently note in the case of a patient coughing vigorously and expectorating during a roentgenoscopic examination that the large shadow diminishes almost to disappearance as the contents of the sac are expelled.

During the early stages of bronchiectasis diagnosis sometimes can be made only from the incongruity between the roentgenogram and the clinical finding. A widening of the bronchi can occur only as a result of injury to the bronchial wall. Conditions predisposing to such a result are the bronchopneumonias, extensive pleuritis and bronchiolitis following whooping cough, measles and influenza. During the early stage of the disease clinical cure is possible, but where the bronchiectasis is extensive, the prognosis appears to be generally unfavorable. Seven cases are briefly cited.

KNIPPING, H. W., and PONNDORF, W. The filling of the lungs with iodized oil. *Beitr. z. klin. Tuberk.*, 1926, lxiii, 327–359.

A method for the rapid determination of inorganic iodine in the urine was developed and was employed in determining the excretion in cases in which the old, 10 per cent iodipin and the present 40 per cent iodipin were employed. It is concluded that in the modern 40 per cent iodipin, the iodine is held considerably more tenaciously than in the older form.

The urinary excretion of iodine was determined in a number of cases after various lung injections with 40 per cent iodipin. Former claims that the lung tissue is able to absorb a certain amount of the injected iodized oil appear to be erroneous. Apparently what happens is that the oil reaches the gastrointestinal tract and is then absorbed and excreted in the urine. Experiments made upon dogs demonstrate that the pulmonary absorption of iodipin is very small when the connection between the trachea and esophagus is separated. A series of cases of clinical and roentgenological interest confirm these conclusions regarding the sojourn of iodipin in injected lungs.

The resorption of iodized oil from the lung is vanishingly small,—much smaller than was expected from a study of the literature. If this absorption is of general significance it would

indicate that the hope of administering medication such as insulin and other substances through the lungs is doomed to failure. The lung tissues may tolerate injected materials but there is no reason to expect that it will absorb them.

The fact that the iodipin shadows produced in lungs gradually become fainter with time is shown to mean that the iodipin is ejected from the lungs and not absorbed through the lungs. This has been demonstrated even in patients who showed very little, if any, cough reflex with the oil in the lungs.

Although the amount of iodine in the iodized oil injected is generally not any more than is usually given in therapeutic doses, one should be very careful about employing this material in cases of hyperthyroidism, disturbances of kidney function and in cases of idiosyncrasy to iodine. Since there are cases of mild hyperthyroidism that are easily overlooked, it is advisable whenever there is suspicion of mild hyperthyroidism without the presence of clinical symptoms to subject the patient to a basal metabolism test. Kidney function test is also indicated in doubtful cases.

Since the intratracheal administration of iodipin by puncture or introduction through a catheter is disagreeable for the patient, insufflation of the finely atomized iodipin has been suggested. The lung shadows produced by the latter method seem to be satisfactory, but since there is danger of some absorption of the oil through the stomach, one should have the patient expectorate saliva and irrigate the nose and mouth after the inhalation.

LYNHAM, J. E. A. Radiography of the chest in tuberculosis. *Brit. J. Tuberc.*, April, 1926, xx, 61–66.

The technique must be good if the roentgenogram is to be of the greatest service. The roentgen tube must not be too hard or detail may be lost; and the patient must be in a comfortable position or gross movement may occur. The upright position is preferable for routine work, and it is better for the patient to sit than to stand for all but the shortest exposures. The distance from the anticathode to the film should be over rather than under 30 inches. The patient should not lean against the cassette but should just touch it. The use of a heavy current through a soft tube, for the shortest possible exposure insures the greatest uniformity in films and largely eliminates blurring due to the movements in the lungs which are associated with the pulsation of the heart. Over-development of films is sometimes responsible for faulty interpretations.

It is questionable whether roentgenography can detect what is, in the pathological sense, early tuberculosis. By the time the changes induced by the morbid processes have reached such proportions as to be demonstrable roentgenologically the disease is usually well established. But it sometimes occurs that by indicating changes in definite areas of the lung fields, the roentgenologist may be of material help to the clinician, and it rarely happens that a film will fail to show confirmatory evidence of the disease when the physician has found even doubtful signs. Where the roentgenographic results are inconclusive repeated examinations should be made.

In some children, as time goes on, enlarged hilic glands become larger and may show variations of density which suggest the possibility of caseation. These should be regarded as tuberculous. When glands of this type are recognized in a child, careful examination should be made in certain areas, namely, the outer part of the infraclavicular regions, the apices of the lowest lobes, the true apices of the lungs, the upper part of the upper bronchial area about 1.5 inches below the clavicle, and the outer part of the bases of the upper lobes.

In the adult, the most frequent site for the earlier opacities is said to be below the outer end of the clavicle, although the true apex is often involved. In a series of suspected adult cases showing neither physical nor roentgenological signs but who were kept under observation, the characteristic opacities were first detected in an irregular chain extending outward and backward from the lung root where old glands were evident. Tuberculosis of the distal portions of the lung without the presence of shading suggesting disease at the root areas is almost never seen.

Extension of the disease is marked by the appearance of successive groups of faint opacities. In the more chronic types the opacities appear to increase in number for a time and gradually become merged into a large diffuse shading which marks the process of extension in the diseased area. Caseation once established may remain unchanged over long periods, or may come to show more or less absolute opacity due to calcification. In the late stages of tuberculosis, there may be enormous cavities and massive collapse following bronchial occlusion.

Healing is evidenced by cicatricial contraction. Individual nodules may be encapsulated, or larger areas of the diseased lung may become fibroid, showing a slowly increasing opacity with but little lighting up or expansion on inspiration.

McKelvie, B. An aid to the radiography of the maxillary antrum. *Brit. M. J.*, July, 1926, ii, 58–59.

As an aid to the diagnosis of choanal polypus and new growth of the antrum, where ordinary roentgenography is often useless, the following method is suggested: Lipiodol is injected with a syringe into the antrum. If a lateral and anteroposterior view are taken, a fairly accurate idea of the position and extent of the growth can be obtained. The method is also useful in giving an outline of the sinus and showing the extent of alveolar recesses.

Puncture is made after cocainization, though the inferior meatus of the nose, the middle meatus having previously been packed with wet cotton extending as far back as possible in order to prevent the lipiodol from escaping by way of the normal and accessory ostia. The lipiodol may be removed with the syringe, or in other cases, if the antrum is to be opened surgically later the lipiodol may be left *in situ* until operation.

With this procedure one may ascertain whether a choanal polypus is coming from the antrum and its point of attachment.

Masmonteil, F. Roentgenographic examination of the female genital organs with lipiodol. *Semana med., Buenos Aires*, Apr. 8, 1926, xxxiii, 737–738.

The author has used the method of lipiodol injection into the uterus and finds it is not in the least harmful or even unpleasant for the patient. It is a very accurate method of diagnosis for some gynecological conditions, including simple abortion, extrauterine pregnancy, fibroma and ovarian cyst. It is possible by means of it to show the cause of some cases of sterility, as it demonstrates impermeability of the tubes. It also sometimes shows incontinence of the tubes as the cause of menstrual intraperitoneal hemorrhage. In these cases the fluid injected collects in Douglas' pouch without causing any contraction of the mouth of the tube. Even in cases in which the liquid escapes into the peritoneal cavity it does no harm. In one case 20 c.c. of lipiodol flowed through the tube into Douglas' pouch. The patient did not feel any pain or inconvenience either at the time of the injection or afterward and laparotomy some days later did not show a sign of peritoneal reaction.

MacCready, Paul B. Iodized oil as an aid in the diagnosis of chronic sinusitis and of maxillary cysts. *Boston M. & S. J.*, Sept. 2, 1926, cxcv, 464–467.

Iodized oil will show the amount of polypoid degeneration and thickening of the mucous membrane of the sinuses and in that way indicate the existence of a chronic infection. So far as can be determined, this oil is entirely free from untoward effects when used as an opaque medium in the roentgenographic study of the paranasal sinuses.

The author has used a 10 per cent solution of iodipin. A trocar is inserted and the antrum is irrigated with sterile saline in the usual manner in order to wash out free pus. Care should be taken to remove all the saline solution, and then about 5 c.c. of the iodipin is injected into the antrum through the trocar using a small rubber bulb, such as an air syringe. The exact amount of oil gotten into the antrum is unimportant if the patient remains upright, because of the great variations in size of the antrum. Roentgenograms are made as soon as possible after injection, stereoscopic views being taken in the anteroposterior and lateral positions.

For injection into the frontal and sphenoidal sinuses, a small silver cathether is used in place of the trocar, and similar technique is carried out. Usually catheterization of these sinuses can be done only after a part of the middle turbinate has been removed. The ethmoid sinuses cannot be injected, but much can be learned from the course of the iodized oil in the nose as it passes back into the nasopharynx. Normally the cilia carry it back into the nasopharynx very rapidly and in definitely established currents.

Two case reports are given; one of a chronic sinusitis in the maxillary antrum and the other of a maxillary cyst. In both of these cases the ordinary roentgenogram was of no use in fixing the diagnosis, but after the injection of iodipin the thickening of the lining of the antrum established the diagnosis in the first case, and in the second case established the existence of a dental cyst of the so-called infectious type.

The iodized oil remains in a sinus for a variable period. In the antrum, traces of it can usually be found at the end of twenty-four hours. This is especially true if the antrum is diseased. Removal from the frontal sinus is much quicker than from the antrum. Little therapeutic use can ever be expected from the use of iodized oil as it is removed from the sinuses too rapidly.

Miller, Richard H. Cancer and diverticulitis of the large intestine. *Boston M. & S. J.*, Aug. 5, 1926, cxcv, 253–257.

The occurrence of indefinite lower abdominal symptoms in a person of cancer age should make one suspicious of cancer; and suspicion should always lead to an examination of the stool for blood, and, still more important, a

roentgen examination after an opaque enema. In the diagnosis of cancer of the colon, the enema is much better than the barium meal. The same picture may, although infrequently, be caused by peridiverticulitis. The degree of operability cannot be determined from the roentgen findings. Cancer of the cecum is the hardest of all to diagnose. Operative treatment of these conditions is the only method offering any chance of cure. Irradiation with roentgen rays or radium has not yet been shown to be of any help.

Diverticulitis of the large intestine is not so uncommon as is ordinarily supposed and usually occurs in the sigmoid flexure. In any case which seems like appendicitis but in which the symptoms and signs are in the left side, diverticulitis should be suspected. For this, conservatism is preferable to radical surgery. In diverticulitis there is usually a history of repeated attacks with more or less fever. The roentgenogram will show up some diverticula but it is not to be depended on in making a diagnosis.

Five cases are presented showing difficult and unexpected problems in surgery of the large intestine.

MOULONGUET, P. The roentgen lesions of certain forms of acute arthritis of the hip. *J. de radiol. et d'électrol.*, March, 1926, x, 115–119.

Very little has been published in regard to roentgen changes in acute arthritis but the author believes that in many cases of acute coxofemoral arthritis destruction of bone by erosion can be seen at the upper pole of the joint. He describes 3 cases, all of them in adults in which the roentgenograms showed considerable enlargement of the cavity of the acetabulum and destruction of both bones, that is, a veritable intra-acetabular luxation. The lesion was a compressive ulceration of the roof of the acetabulum due to rarefying osteitis. The frequency of this picture in acute arthritis is not known. It is certainly not constant and the author has seen 2 cases in which it did not appear at all. Its etiology varies. Two of his cases were of post-puerperal arthritis and the cause of the other is not known. Other authors have cited cases in pneumococcus arthritis and typhoid arthritis. But all cases of arthritis with this etiology do not cause secondary bone lesions; he has seen one case of post-puerperal arthritis which did not present the least erosion of the acetabulum. His cases were in adults, those of Lamy in young children, showing that these bone lesions may occur under very different circumstances.

He believes that the position of the limb during the acute stage of the arthritis plays an important part in the production of the compressive ulceration. In all 3 of his cases the limb had been left in a bad position of adduction-flexion. The intra-acetabular luxation of tuberculous coxitis is produced in the same ways. The similarity of these lesions to those of tuberculous coxitis is the important point about them. But the process of repair is much more rapid in acute pyogenic arthritis than in tuberculosis. At the end of three months of correct immobilization in his cases cure was brought about, with roentgen signs of bone repair; the roof of the acetabulum was reconstructed and the new bone was very dense; it was a process of condensing osteitis, such as is seen in tuberculous coxitis at the end of three years. It is important to know that this compressive ulceration with intra-acetabular luxation may occur in acute arthritis as it may protect the examiner from making a mistaken diagnosis of congenital dislocation of the hip or an old coxitis.

MÜLLER, WALTHER. The development of coxa valga through epiphyseal displacement. *Beitr. z. klin. Chir.*, 1926, cxxxvii, 148–164.

Apart from the acute systemic diseases of the skeleton which lead to changes in the angle of the neck of the femur and other epiphyseal conditions terminating in coxa valga, there occurs a displacement of the epiphysis toward the neck of the femur in the lateral direction, a process which is of considerable importance in the understanding of most forms of coxa valga. The possibility for such a lateral shift of the cap occurs only in those particular cases where the space between the lateral acetabular edge and the upper lateral edge of the femur is greater than the greatest height of the cap of the femur. Wherever the edge lateral of the acetabulum and the upper lateral end of the neck of the femur happen to be separated considerably from one another, where larger lateral portions of the head are out of contact with the acetabulum, the epiphysis of the femoral head shows a tendency to lateral displacement over the neck of the femur.

In order to distinguish these relationships in the roentgenogram with complete distinctness, it is necessary to take the picture of the neck of the femur at a correct angle. The usual roentgenograms taken with external rotation of the limb are absolutely useless for this purpose, as they very easily give the impression of a certain shift of the cap toward the major trochanter. The necessary films must be taken with the limb in normal position or with internal rotation of the leg.

The consequence of a lateral shift of the epiphysis upon the neck of the femur is a coxa

valga. The end of the femur appears straighter although the neck itself still maintains practically the same angle as in the normal. As in the case of coxa vara of adolescence, there later follows an adaptation of the contours of the femoral neck to the new position of the cap. The median edge of the femoral neck runs somewhat straighter in a convex curve and the upper edge runs toward the outwardly shifted lateral edge of the epiphysis and appears shortened. Through further osseous appositions to the now horizontally placed symphysis, there results subsequently a femoral neck which is really straight. Consequently the displacement of the epiphyseal joint will be found fully developed in only a certain relatively early period, but the later genuine coxa valga is the end effect of this early epiphyseal displacement toward the outside.

This explanation permits an understanding of a variety of forms of coxa valga which have hitherto been only vaguely understood as regards their genesis. This is proven by an examination of the conditions in (1) coxa valga following flattening of the acetabulum (coxa valga luxans); (2) coxa valga due to vertical position of the pelvis; (3) coxa valga due to muscular tension; (4) coxa valga in genu valgum, and (5) coxa valga in inflammatory conditions. In most cases of these types, a shifting of the epiphysis toward the neck of the femur is the causative factor, the shift being laterally and upwardly. The condition permitting this lateral shift of the epiphysis, which takes place very gradually, is firstly the incomplete articulartion of the head only in its medial sections with a flattenning or vertical position of the acetabulum; and secondly, it may be caused by a permanent position of adduction of the femur.

Negro, Mario. Cystoscopy and roentgenography in calculus of the bladder. *Arch. ital. di urol., Bologna*, January, 1926, ii, 223–255.

Both cystoscopy and roentgenography are valuable aids in the diagnosis of vesical calculus and either the one or the other method suffices in a great many cases. But there are certain cases in which each method fails entirely or is insufficient for a definite diagnosis. Cystoscopy cannot be used in cases where it is impossible to introduce the cystoscope, as for example in children, in cases of stricture, in certain anomalies of the urethra and in calculosis of the urethra. And it cannot be used sometimes because of certain special conditions in the bladder, such as intense cystitis, which renders any distention impossible and copious hemorrhage or pyuria of the bladder which obscure the view. Cystoscopy may be insufficient or lead to mistakes in interpretation by reason of masses of detritus in the bladder such as blood clots or masses of pus, and in encrusted cystitis and encrusted tumors of the bladder. It may also fail in cases of calculi covered with clots and fibrin or ones completely enclosed in a mantle of organic tissue. And it may not show a calculus in spite of the cystoscopic picture being clear in calculi situated in a very deep vertex of the bladder which the cystoscope does not reach, calculi located in cystoceles or vesical herniae, calculi "capped" with a piece of vesical mucous membrane, or calculi in vesical diverticula.

Roentgen examination may fail to show a vesical calculus because of excessive thickness of the walls of the abdomen which renders the bladder region opaque, or because of the chemical composition of the stones. Uric acid calculi and ones composed of ammoniacal calcium urate are not visible. Roentgen examination may lead to mistaken diagnoses in cases of shadows cast by encrusted bladder tumors, encrusted cystitis or encrusted clots or masses of pus or by reason of certain paravesical lesions impermeable to roentgen rays, including calcified cysts of the pelvis, dermoid cysts, calcified gummata and intestinal calculi.

As each of the two methods may be insufficient in the conditions outlined above and as the causes of failure are not the same for the two methods errors of diagnosis in calculus of the bladder can be greatly reduced by making systematic use in doubtful cases of both cystoscopy and roentgenography.

Pehu, H., Chassard, M., and Enselme, Mme. J. Roentgen study of congenital syphilis of the long bones in early infancy. *J. de radiol. et d'électrol.*, February, 1926, x, 54–68.

The author has made a study of the roentgen picture of syphilis from birth to two years of age and presents plates showing the results. There are four forms, the first two of which are rare. The gummatous form is very unusual although it is frequent after three years of age. The osteomalacic or destructive form is also unusual; it presents various phenomena due to dystrophy of bone tissue. The bones are very fragile and these infants often have multiple fractures. There seems to be a sort of rarefaction of the spongy tissue, a variety of osteoporosis. The roentgenograms show notches or lacunae, a dentate or worm-eaten appearance at the ends and along the edges which represent either true losses of substance or a rarefaction of the bone. There are no clinical symptoms and the condition is discovered only by roentgen examination.

The two other forms are frequent. Wegner-Parrot's osteochondritis is a disease of intrauterine life. It is generally discovered only by roentgen examination, for Parrot's pseudo-detachment of the epiphysis is the clinical manifestation of its maximum degree. It is only exceptionally found after the third month of life. It is characterized by dentate processes extending from a variable depth between the proximal face of the articular cartilage and the juxta-epiphyseal part of the spongy tissue. The process of calcification does not follow a normal course. Instead of being superimposed, as they are normally, the zone of calcification and that of cartilage interpenetrate each other reciprocally and irregularly. Osteogenesis is excessive in some places and defective in others. Soon necrobiosis occurs, due doubtless to defective arterial circulation, which alters the spongiosa already formed and the periosteum itself presents signs of hyperplasia. The fourth form, ossifying or hyperplastic periostitis, is found in 80 per cent of cases of syphilis in early infancy. Generally it shows no clinical symptoms. In the majority of cases it appears with absolute symmetry in the bones of the four limbs. It is an extra-uterine disease beginning in the first three months of life and extending up to the 18th month. The roentgen picture is almost pathognomonic. It is caused by the embryonic layer of the periosteum becoming affected by the syphilitic infection. Under the influence of the irritation caused by the spirochetes this layer manufactures granulations which penetrate the cortex and finally become encrusted with calcium salts. There is a sheath of calcified periosteum which often surrounds the whole length of the long bone; its outlines are generally regular but sometimes there are localized projections.

PINCHERLE, PINO. Roentgen findings in pertussis. *Pediatria*, March, 1926, xxxiv, 316–320.

There are three types of roentgen picture in whooping-cough. In the first type the lines which radiate from the hilus are delicate and pass for only a short distance into the parenchyma; they are more numerous in the subclavicular region than farther down. Between them there are numbers of small rings with a thin opaque circumference and intensely clear center. They are most numerous around the hilus and in the subclavicular fossae, but are also found in distant parts of the lung, even in the apices. This type is found in the catarrhal stage and the beginning of the convulsive stage.

Type 2 is the most characteristic and is found at the height of the disease. The opaque stripes have greatly increased in number and in breadth. They pass into the parenchyma in all directions and reach the most distant parts of the lung, forming an inextricable tangle of lines. They are not always uniform in width throughout their course. At the hilus there are no longer delicate stripes irradiating in a stellate form, but large shadows of moderate intensity and hazy outlines characteristic of enlargement of the glands. The circles seen in the first type are increased in number and are now localized along the lower bronchi also; the mediastino-diaphragmatic part of the lung is most compressed and here there are rings of all sizes, some of them with a thin line forming the circumference but many with an opaque circumference larger than the lumen. The lumen varies from a mere point to several centimeters in diameter.

The third type is found in very severe and complicated cases of whooping cough and shows all the signs described above in an intense form and others due to whatever complications may exist. Mediastinal pleurisy is frequent; the author saw two cases of semilunar opacity due to mediastinal pleurisy. In one case there was an accumulation of gas due to mediastinal emphysema which caused the death of the child.

The rings are the outlines of small bronchi struck tangentially by the rays. They are dilated from the constant attacks of coughing and in the second type the outlines are thickened from the dense secretion contained in them. The bronchi that are struck longitudinally show heavy lines due to the thickening of their walls. The blood vessels and lymphatics which under normal conditions form the lung outline are dilated and gorged because of interference with the circulation during the attacks of coughing. All these factors combine to give the typical roentgen picture of pertussis.

The picture is valuable not only in diagnosis but also in prognosis and treatment; it is particularly useful in establishing the indications for radiotherapy which has proved very satisfactory in many cases.

REDEKER, FRANZ. Infraclavicular infiltrations, their developmental forms, and their relation to tuberculosis of puberty and to the problem of phthiseogenesis. *Beitr. z. klin. Tuberk.*, 1926, lxiii, 574–600.

There is a form of post-childhood tuberculosis in which the first manifestation is not localized in the apex but somewhat laterally under the clavicle or somewhat deeper in the middle field. This earliest sign is usually demonstrable only roentgenologically and not by percussion

or auscultation. It may be frequently demonstrated to be a lymph node swelling, usually with perifocal inflammation. During this stage there are no symptoms and there is no complaint nor any subjective or objective signs such as coughing, stabbing pains or general toxic symptoms. These early stages of infraclavicular infiltration are consequently discovered only as a result of regular examinations of healthy persons suspected of exposure to tuberculosis. This particular form of tuberculosis develops usually in young persons between the ages of fifteen and twenty, occasionally in the next quinquennium and only rarely in older individuals. Very often in such cases there can be demonstrated an actively progressive source of infection.

This type of infection possesses a peculiar ability to develop in a variety of ways. Two modes of development are so-called infraclavicular fusion and infraclavicular dissemination by aspiration, each of which has a great capacity for regression at any stage of development.

The infraclavicular infiltration is not a primary focus or an immuno-biologically related form, but appears to be the product of a strong vegetative reactivity closely related to the early, secondary allergic period, wherein a more or less considerable superinfection may be of great importance but is not absolutely necessary. The so-called phthisis of puberty is an unfavorable stage of development of the type here discussed. Pulmonary tuberculosis of puberty is, as a general rule, not benign but nevertheless is more favorable than the "tuberculosis of puberty" seen in the autopsy room.

The cures frequently reported of the isolated round cavity have occurred mostly among cases of infraclavicular infiltration where the secondary allergic tendency was active.

ROBERTS, R. E., and COHEN, MORRIS J. Osteitis deformans (Paget's disease of bone). *Proc. Roy. Soc. Med., Lond.*, March, 1926, xix, Sect. Electro-Therap., 13–40.

Sixteen cases of osteitis deformans are recorded (11 males and 5 females). The general features observed conform to the more than 300 human cases that have now been recorded in the literature.

The etiology of the disease is doubtful. The factors that have been suggested as possibly responsible are (1) toxins; (2) endocrine disturbances; (3) heredity or environment, and (4) syphilis. In the present series, 2 of the patients were sisters, and 2 others showed a positive Wassermann reaction. In only 2 cases did the symptoms appear before the age of forty. In 11 cases the earliest symptom was pain in the lower limbs. Muscular weakness, cramps, deformities, fractures and head enlargement were usually later manifestations. In 3 cases spontaneous fracture of the femur occurred; in one case twenty incomplete "cracks" were found roentgenologically in the convex anterior border of the tibia, and three in the femur. The pathologic process in Paget's disease is one of "halisteresis" or a progressive decalcification and resorption of the old bone and replacement by an osteoid tissue.

The roentgenographic appearances illustrate the various stages of this pathologic process. In the skull the earliest roentgenographic change is a blurring of the outline of the calvarium with, as a rule, thickening and "flattening." The later changes are those produced by progressive thickening with irregular calcification in the osteoid tissue, frequently affecting the base as well as the vertex. Enlargement of the pituitary fossa was shown in 3 cases.

In the long bones one of the features is the production of "trabeculae" in the thickened cortex. These are at first faint, gross, and ill defined, but later become denser and more sharply defined. The stage of the disease in any bone can be gauged by the type of trabeculae shown in the roentgenogram. Fractures occurred only when the bone was in the early amorphous or faint, blurred, trabecular stage. Occasionally, as in the metacarpals the roentgenographic shadows indicate a dense, granular deposit of calcium in the thickened cortex; in the os calcis the appearances may be merely those of coarse trabeculae along the normal lines of lamellation.

In 8 cases of the present series the diagnosis of the disease was primarily roentgenographic. Characteristic roentgen changes were found in the skull in 15 cases, pelvis 15 cases, femur 15 cases, and tibia 15 cases. Roentgen changes were often found in parts quite unsuspected of disease of any sort. This emphasizes the necessity for: (1) local roentgenographic examination of cases of obscure limb pain; (2) general roentgen examination of the skeleton (especially skull and pelvis) in all cases where suggestive local bone changes have been found. Where the local roentgenographic changes suggestive of "osteitis fibrosa" were found, a general roentgen examination invariably showed appearances which were characteristically those of "ostetitis deformans." Roentgenologically it is impossible to differentiate between generalized osteitis fibrosa and osteitis deformans. Osteitis fibrosa cystica which may be localized to a single bone is probably a different disease or at any rate a different type.

The treatment of osteitis deformans is at present very unsatisfactory.

SCHELLENBERG, G. On the clinical picture in pneumoconiosis. *Beitr. z. klin. Tuberk.*, 1926, lxiii, 179–181.

The roentgenological picture of the coniotic lung is characterized mainly by the processes of condensation usually developing systematically, preferably in the middle portions of the lung. The clinical symptoms are usually slight as compared with the relatively marked roentgen findings. In pulmonary tuberculosis, the densest shadows are generally found in the upper fields, while the coniotic shadows, on the other hand, are always in the lower fields.

A very striking case of chalicosis of the lungs was observed, in which there was found a surprising symmetry in the changes in both lungs, the localization, however, being in the upper fields. The shadows were sharply outlined in the lung areas. It is assumed that the sharp delimitation was produced by a reaction of the lung tissue and not of the pleura. The clinical symptoms, however, indicated a probable participation of the pleura, since the patient complained of breast pains. All the hilic markings appear to be drawn upward, and the contraction of the vascular shadows indicated that the coniotic area had undergone fibrosis of an advanced degree.

The case, occurring in a mosaic worker forty-four years old is described in detail.

VAN DESSEL, ARTHUR. Calcification of gliomas of the brain. *Arch. franco-belges de chir.*, October, 1925, xxviii, 845–874.

With recent improvements in roentgen technique, including the introduction of reinforcing screens, the use of the Potter-Bucky grid for eliminating secondary rays, combined with the stereoscopic method, calcifications can be demonstrated now that could not have been shown a few years ago. In an examination of Cushing's material since 1921 the author found that 17 out of 126 gliomas of the cerebral hemispheres, or 13.5 per cent, showed calcification. This does not include the cerebellar gliomas, only two of which showed calcification. It is possible that cerebellar gliomas because of their position do not have as long a life as those of the cerebrum and so do not calcify so frequently, or it is possible that the calcification does not show so well because of superposition of the shadow of parts of the petrous bone. One old case of glioma from 1907 which was not roentgenographed before operation was examined and showed calcification. The author gives the clinical histories and several roentgenograms of the 17 cases of glioma which presented calcification. A study of these cases shows that such gliomas can be accurately localized by roentgen examination. The calcification is found chiefly in gliomas made up of highly differentiated cells, which are therefore the ones in which the prognosis is most favorable. The operative mortality in these cases is very low. The calcium salts are deposited almost exclusively in the walls of the vessels after they have undergone hyaline degeneration.

WILKIE, D. P. D. Coincident duodenal and gastric ulcer. *Brit. M. J.*, Sept. 11, 1926, ii, 469–470.

The author examined 490 bodies post mortem for duodenal ulcer. In 41, one or more such ulcers were found (8 per cent). In 5 cases one or more gastric ulcers were present along with the duodenal ulcers. That is, in 12 per cent of cases of duodenal ulcer a coincident gastric ulcer was found. During the past five years an experience with 300 operated cases of ulcer gave the following incidence of involvement:

	Male	Female	Total
Duodenal ulcer alone	167	54	221
Gastric ulcer alone	17	20	37
Coincident duodenal and gastric ulcer	27	15	42
Totals	211	89	300

The roentgen-ray picture after a barium meal is an important element in the accurate diagnosis of this condition. In the early cases, the roentgen evidence of gastric ulcer may be a little uncertain, and may be confined to a slight irregularity of outline of the lesser curvature with some degree of spasmodic hour-glass contraction. In the advanced cases where stenosis has occurred, the very typical picture of hour-glass stomach and duodenum leaves no doubt as to the diagnosis.

Two groups of cases are to be distinguished when considering operative measures: (1) Active ulcers without stenosis in persons under fifty years of age; and (2) unhealed but cicatrized ulcers with stenosis, in elderly subjects. The Balfour operation is recommended for the first group, while for the second group purely anastomotic operations give a lasting cure.

It seems clearly demonstrated that coincident ulceration in the stomach and duodenum is relatively common. In this series it occurred in 16 per cent of all duodenal ulcers and in 53 per cent of all gastric ulcers.

Van Neck. A case of sacralization of the fifth lumbar vertebra. *Arch. franco-belges de chir.*, June, 1925, xxviii, 505–510.

A girl, aged eighteen, after a fall from a street-car began to have pain in the right lumbar region which increased progressively. There was a very audible and painful cracking sound when she bent forward and the limp increased until she had to walk with crutches. Roentgen examination showed sacralization of the 5th lumber vertebra on the right, but there was a striking discrepancy between the roentgen and operative findings. The roentgenogram showed a large transverse process which reached the iliac bone; it was very large at the base and seemed to be connected with the sacrum also. Operation showed a process not larger than a pencil which was directed forward and attached to the iliac bone 1 cm. below the crest by solid ligaments. It was very hard to remove on account of its close attachment by ligaments to the pelvis and sacrum and because of the copious hemorrhage. Its point of implantation on the vertebra could not be seen. Although the process was not completely removed the pain stopped at once but the cracking sound and the scoliosis were not completely corrected until after about two months.

Yvernault, A., and Montel, L. A case of generalized osteitis with geodes; Recklinghausen type. *J. de radiol. et d'électrol., Par.*, March, 1926, x, 106–111.

A man aged fifty-six had always been well except that he had an operation for stomach ulcer in 1913; at the end of 1914 he was seriously wounded in the buttock, probably with comminuted fracture of the rim of the acetabulum. At the end of 1918 he began to have stubborn and intense pain in the lower limbs, and severe headache, chiefly at night. Those were the symptoms for which he came to be treated. His lower limbs felt weak and examination showed symmetrical amyotrophy of the proximal segments of the limbs. No paralyses or contractures; no history of syphilis, his children are normal and the Wassermann reaction negative. There were hard elongated swellings along the antero-internal surface of the tibia and the lower part of the right ulna. There was intense decalcification of the teeth. The urine contained Bence-Jones albumose.

The nodules on the bones led to a roentgen examination; the skull was found normal in size, though it is frequently increased in this disease. There were many small geodes in the vault, the sella turcica was elongated and the clinoid processes effaced. There were many geodes scattered irregularly throughout the long and short bones; they were unilocular or multilocular, generally ovoid, with indefinite outlines or sometimes with a darker circle around them. They were surrounded by bone tissue that was sometimes normal, sometimes rarefied, sometimes spotted and in a few places denser than normal. Some of these pseudo-cysts were in the cortex and some of them, having reduced the cortex to a thin layer, seemed to invade the marrow canal more or less completely. Around the largest geodes which formed the palpable tumors on the legs and forearms the cortex only formed a wavy outline, but it had not been broken down anywhere. One unusual feature was that at two places on the posterior surface of the tibia there were little rarefied periosteal excrescences. The largest geode was in the neck of the left femur at the site of the wound in 1914 which suggests that possibly this rarefying dystrophy of the bones may have been caused by the trauma. Recklinghausen thinks trauma is very important in the genesis of bone cysts. The patient still has rheumatoid pain in this hip and leg. The evolution of the disease, at least at some periods, is very slow. Two series of pictures taken at an interval of six months have not shown any change in the lesions.

Zanoli, Raffaele. Congenital luxation of the patella. *Chir. d. org. di movimento*, December, 1925, x, 83–164.

Zanoli gives clinical histories of 13 cases, profusely illustrated by photographs and roentgenograms. This is an unusual affection; Karl in 1921 collected 137 cases and 15 have been published since then, making a total of 152. The condition is markedly familial and is frequently accompanied by other anomalies of development, such as luxation of the hip, flat-foot, scoliosis, etc. In one of the author's cases there was complete absence of the joint menisci and the crucial ligaments of the knee-joint. This anomaly has never been described before. The patient's father was syphilitic and she had a doubtfully positive Wassermann.

After discussing the various theories of pathogenesis, the author concludes that congenital luxation of the hip is due to an anomaly in the position of the joint axes, that is to an external rotation of the tibia and an inward rotation of the distal epiphysis of the femur, due to mechanical factors during intrauterine life.

Solieri reports that roentgen pictures of the knee-joint show that in hyperextension the patella occupies the supratrochlear fossa, while in extension the upper part is in the supratrochlear fossa and the distal part in contact

with the trochlear. In moderate flexion the patella moves downward still more, so that only part of it is in relation with the trochlea, and in extreme degrees of flexion it lies entirely in the intercondyloid fossa. The author's roentgenograms of normal individuals confirm those of Solieri and show that in extension the patella occupies the trochlear region, while in flexion it lies lower down and occupies the intercondyloid fossa. He also examined fetuses from 8 to 25 mm. in length; all of them were in the physiological flexed position of the fetus in the uterus and the patella was somewhat higher than in the flexed position of the infant or adult. In those 8, 11, 12 and 14 cm. in length the upper two-thirds of the patella lay at the level of the trochlea, while the lower third was in the intercondyloid fossa, while in fetuses 18 and 25 cm. in length it had moved down until half of it lay in the intercondyloid fossa.

The roentgen pictures in congenital luxation show the patella displaced outward, more or less marked decrease in the intercondyloid fossa, and a marked decrease in the articular fossa of the tibia, which in some cases occupies only a small part of the internal articular surface of the bone. The roentgenogram in some cases shows an inward displacement of the axis of the femur, a real lateral displacement and not the simple deviation of valgus. In the lateral projection the outlines of the lower epiphysis of the femur in some cases are rather flattened and the margins of the two condyles are not superimposed.

There are four chief methods of treatment of this condition: operations on the bone, operations on the ligaments and capsule, operations on the muscles, and mixed operations. The author used various methods in his cases and comes to the conclusion that perhaps the best one is combined median transplantation of the patellar tendon and capsulorrhaphy. In connection with median transplantation of the patellar tendon he emphasizes one point in technique, namely the disinsertion of the quadriceps tendon. He used this method in 4 of his cases and in one of them particularly after having cut the insertion of the vastus externus and the lateral attachments of the patella he could flex the knee without luxation of the patella. This detail of technique is justified by the fact that one of the most characteristic changes in this affection is external displacement of the whole extensor system—quadriceps, patella, patellar tendon—and this is the best method of restoring the extensor apparatus to its normal relations, re-establishing normal function and guarding against recurrence.

ROENTGEN AND RADIUM THERAPY

BÉCLÈRE and SIREDEY. Intra-abdominal tumor cured by roentgen therapy without recurrence after five years. *Bull. Soc. d'obst. et de gynéc. de Par.*, March, 1926, xv, 166–167.

A woman aged fifty-four, teacher and directress of a school, was examined in June, 1920 and showed an unusual splenomegaly without leucemia which could not be attributed to malaria, syphilis or tuberculosis. In June, 1916, she had had a tumor the size of a fist removed from the external orifice of the left inguinal canal. She had never menstruated. As a matter of fact, though she had all the appearance of being a woman it was a case of external masculine pseudohermaphroditism. At the external orifice of the right inguinal canal, exactly symmetrical with the operation scar, there was a smooth hard oval body pressure on which caused nausea. It was assumed to be testicle and it was found from the histological report that the tumor removed some years before had been a seminoma. A diagnosis of metastatic seminoma of the spleen was made and roentgen treatment begun July 3, 1920 and terminated Dec. 16 the same year, 20 treatments having been given, at first weekly and later at longer intervals. Ten days after the first treatment although small doses of moderately penetrating rays had been used the spleen had greatly decreased in size; a month and a half later it was normal in size. The irradiations were continued as a precautionary measure. Seminomas and their metastases are very radiosensitive. At present ten years after the original operation and five years after the roentgen treatment of the metastasis there are no signs of recurrence.

BÉGOUIN. Two cases of death from intrauterine use of radium. *Bull. soc. d'obst. et de gynéc. de Par.*, February, 1926, xv, 137–138.

Among the 137 cases in which the author has used radium within the uterus for cancer of the body of the uterus or the cervix he has had one case of slight peritoneal reaction with recovery and two deaths. The first was a case of basal cell epithelioma; on account of the patient's stoutness and the depth of the vagina he thought either abdominal or vaginal hysterectomy was dangerous and so used two tubes of radium tandem; each contained 13 mg. radium element filtered through 0.5 mm. platinum and 2 mm. gold, all enclosed in a tube of metallized rubber. The radium was applied Nov. 24, and removed Nov. 28. As the number of millicuries was insufficient the radium was

re-introduced; for the next few days the patient's temperature varied between 36.4° and 37.8°C. On Dec. 3 the radium was removed and that evening her temperature rose to 38.4°C. On the 5th her abdomen was distended, her general condition bad and the bases of her lungs congested. On Dec. 9 she died. Autopsy showed the abdomen full of pus and a large triangular perforation of the uterus on the posterior wall at the site of the cancer.

He had another similar case of death where radium was introduced into the uterus for cancer of the cervix but in this case, an autopsy did not show any perforation of the uterus; the infection must have taken place by the lymphatic route.

Bolaffio, Michele. Treatment of insufficiency of the ovaries with roentgen rays. *Clin. ostet.*, January, 1926, xxviii, 2–22.

Bolaffio gives a table showing the cases of ovarian insufficiency which he has treated and the doses used. He finds that irradiation of the ovary with small doses is effective in (1) primary or recent amenorrhea; (2) opsomenorrhea which he defines as menstrual flow retarded in time but normal in amount, and (3) the menorrhagia of puberty. It is only rarely and incompletely successful in (1) old and secondary amenorrhea; (2) hypomenorrhea, and (3) secondary hypermenorrhea. Irradiation of the thyroid has given good results in hypermenorrhea with hypertrophy of the thyroid; irradiation of the hypophysis and unilateral castration did not give good results.

It seems that the effect of irradiation with small doses is not due to a stimulating action of the rays on the tissues, but rather to destruction of pathological follicles which are particularly sensitive, and perhaps also to humoral reactions at a distance.

Irradiation of the ovaries with small doses is harmless.

Caufman, H. Cure of a case of sterility due to functional ovarian disturbance by deep roentgen therapy. *Paris méd.*, Feb. 6, 1926, xvi, 135–138.

As it is known that sterility can be brought about by a dose of roentgen rays it seems paradoxical that ovarian function can be stimulated by the same treatment. Possibly it is due to the stimulant action of small doses of rays, but at any rate the fact exists and the author reports an illustrative case.

A woman aged twenty-seven came to him July 1, 1924 complaining of metrorrhagia. She had begun to menstruate at the age of thirteen and had a menstrual period lasting seven days every two or three months. At the age of nineteen, during the war, her menstruation took on the character of a menorrhagia lasting two months; this condition lasted for about a year when an irregular oligomenorrhea began. From 1922 on the patient has had alternating periods of amenorrhea and prolonged polymenorrhea. She had been married a year and a half and had never been pregnant. In August, 1923, her physician thinking that she had a hemorrhagic metritis performed a curettage and for a while menstruation became regular. But in January, 1924 the metrorrhagia recommenced. A second curettage was performed in May of that year but the metrorrhagia began again at the end of a week. On examination the genital organs were found entirely normal, so the disturbance was a purely functional one.

The author gave roentgen irradiation according to Flatau's technique: two large fields of irradiation 18 by 20 cm. extending from the umbilicus to the bottom of the pelvis, one abdominal and the other lumbosacral; 13 to 14 per cent erythema dose at 10 cm. depth with a neointensive Veifa apparatus, corresponding to $\frac{1}{2}$ erythema dose at the surface; filter 0.8 copper and 1 mm. aluminum, 3 ma., 23 cm. focus-skin distance, 200,000 volts, Coolidge tube. This treatment was followed by three normal menstruations and then by amenorrhea due to pregnancy. She was delivered of a normal girl Aug. 4, 1925.

This may have been due to a stimulating action on the ovary or to a destructive action on the weaker of the several follicles that evidently matured at the same time, allowing one to develop normally into a corpus luteum. This treatment is applicable only in functional disturbances, not in agenesia or aplasia.

Commandeur-Eparvier and Michon. Cancer of the cervix of the uterus and pregnancy; Caesarean section; Porro's amputation; radium therapy *Bull. Soc. d'obst. et de gynéc. de Par.*, January, 1926, xv, 59–62.

A woman aged forty who had had four children, the last one ten years of age, was sent to the hospital July 31, 1925 for a seven months pregnancy and cancer of the cervix. During the night of the 21st of August she had a very severe hemorrhage. Her general condition was very bad and the pulse could not be felt. She was given stimulants and the next morning a classical Caesarean section was performed under ether anesthesia. A normal girl weighing 3000 gm. was extracted. Porro's amputation was performed at once and the abdomen closed. Two weeks after the operation the gangrenous part of the stump was resected.

The cervix was dilated by Hegar bougies up to No. 12 and two tubes of radium bromid containing 50 mg. each introduced through the abdominal orifice; usual quadruple filtration. Three tubes of 75 mg. each were placed in a circle around the cervix. Therefore a total of 325 mg. radium bromid was applied for seventy-two hours, or 57.6 mc. After removal of the tubes transcervical drainage was established for a week. Three days after the tubes were removed her temperature rose and oscillated between 37° and 39° for eleven days and during this time there was incontinence of urine. The patient weighed 60 kilograms on Aug. 1 and on her discharge Nov. 6 she weighed 45 kilograms. During the last fifteen days of her stay she regained her appetite. Vaginal palpation three weeks after the radium was applied showed that the large cervical tumor had completely disappeared. The cervix was small and hard; there was slight induration in the cul-de-sac on the right.

Michon believes that this method of applying radium through the abdominal orifice after Porro's amputation is a very satisfactory technique. If radium is used during pregnancy it should be applied only in the vagina. Intracervical application is generally followed by abortion or premature delivery.

COUTARD, H., and REGAUD, Cl. Results and technique of roentgen therapy of cancer of the cervix of the uterus. *J. de radiol. et d'électrol., Par.*, April, 1926, 151–154.

From 1920–1923 the authors treated 32 cases. All except one were absolutely inoperable. The patient who was operable died. Treatment with radium after failure of roentgen rays brought about only temporary improvement. Of the 31 inoperable cases 6 were not able to stand the treatment and it had to be given up. Of the remaining 25, seven are still alive and free of symptoms of cancer one was treated in 1920, one in 1922 and 5 in 1923; this give 28 per cent cures. Most of the patients not actually cured were greatly improved and some of them are living two and three years after treatment.

Three methods of treatment have been followed: (1) by roentgen rays alone: 12 of the 32 cases were treated in this way; in 3 the treatment had to be given up and 4 of the other 9 are cured, or 44.4 per cent; (2) treatment first by radium and then by roentgen rays; most of the 10 cases treated in this way were ones of recurrence after radium treatment and none of them recovered. This confirms what the authors have found in skin cancer, namely, that roentgen rays are ineffective after radium treatment; (3) treatment by roentgen rays first followed by radium treatment; 10 cases were treated in this way and 3 recovered, or 33 per cent.

The authors have never had any serious skin reactions. In the early period of their treatment when they were using relatively small skin fields and a filtration of 1 to 1.5 mm. zinc they frequently had more or less disturbing intestinal symptoms and changes in the circulation and blood picture, but since enlarging the fields and using 2 to 2.5 mm. zinc they have never had any of these symptoms.

Their present technique is to use a maximum tension of 180 kv., a filtration of 2.5 mm. zinc, skin-anticathode distance of 0.50 to 0.75 meters and fields of 375 to 450 sq. cm., the number depending on the case. The Germans in general prefer small fields and slight filtration, 0.5 to 1.0 mm. zinc or copper, and try to measure very accurately so that the rays shall strike only the tumor and not the surrounding tissues. But as such determination of the exact limits of the cancer is almost impossible the authors prefer to use less dangerous and more elective rays. Of course this involves loss of time and the methods of quantitative dosimetry are not very satisfactory. Their skin doses amount to about 60 H units for one-half of the pelvis (about 14,000 Solomon's R units) or for the whole of the pelvis 100 to 120 H. They never exceed 4 to 5 H units (1100 to 1200 R units) per day. The maximum time of treatment is twenty-five days; the results are not so good if it is extended farther. Perhaps it would be well to reduce it to fifteen days or even less, but that is difficult with the tubes now available and besides it produces intolerance in the patient. The total irradiation time is twenty-five to fifty-five hours according to the size of the territory irradiated.

DI SANT'AGNESE, V. ARTOM. Radium treatment of cancer of the cervix and the cervical canal. *Clin. ostet.*, May, 1926, xxviii, 223–233.

The best field for radium treatment of cancer of the cervix is in inoperable cases. The author has treated 413 cases exclusively with radioactive substances. He has used either radium or mesothorium, giving 3 to 4 applications of twenty-four hours each distributed over fifteen to twenty days: dose 50 mg. radium element. If possible an intrauterine or intracervical focus with foci in the vagina for cross fire. Filtration for mesothorium through 1 mm. of brass and for radium through 1 mm. of gold and platinum; external tube of rubber to absorb the secondary radiation. For the applications in the vagina the radium was covered with cork and outside that with rubber. He has found needles useless except to destroy

cauliflower vegetations. He does not use an intrauterine focus if it is necessary to dilate the cervix, for fear of dissemination, nor does he advocate the introduction of tubes through incisions in the fornix of the vagina or the abdominal wall.

Among the 413 cases 25 are excluded on account of recurrence and 170 because operated on since 1920, so the five-year results are not known. This leaves 218 operated upon five years or more ago. Of these 16, or 7.34 per cent, are definitely known to be alive and well. Reports have been received from only 50 per cent and it is probable that there are others still living; they were mostly domestics or working women and it is hard to get in touch with them because of their frequent changes of address. While this is not a high percentage of cures it is to be remembered that they were all inoperable cases, many of them far advanced and no selection was made. In one of the cured cases the treatment was given without any hope of cure, only because the family insisted.

In another series of 127 cases treated successively with radium and roentgen rays since 1920, thirty-five, or 27.6 per cent, are alive after two years or more, which is a high percentage considering that they were all inoperable and some of them advanced. During this same period radium treatment alone has given 19 survivals out of 130 patients, or 14.3 per cent. The combination of radium and roentgen rays would seem from this to be superior to radium alone. In spite of the doubts of its value expressed by Regaud, radium followed by roentgen rays is effective, although roentgen rays followed by radium are more so. The reason the author has sometimes given radium first is to avoid the general disturbance that sometimes follows the primary use of roentgen rays.

In still another series of cases he has used radium following hysterectomy. While this would seem dangerous on account of the removal of the uterus and the close proximity of the bladder and rectum he has found that two treatments of twenty-four hours each with 50 mg. radium element with an adequate metal filter and 2 cm. of cork are well borne. He has never had any injury from this treatment which he has used in 32 cases. It is particularly valuable for preventing recurrence in the vaginal scar. Since 1920 he has used a combination of radium and roentgen rays when possible. Among 29 cases he has had 17 survivals for two years, or 58.6 per cent; among 25, fourteen survivals for 3 years, or 56 per cent, among 14, six survivals for four years or 43 per cent. He thinks therefore that it is better to perform a less radical operation than the Wertheim and follow it up with roentgen and radium therapy than to perform the Wertheim operation.

EDLING, LARS. Treatment of surgical tuberculosis by roentgen rays. *Paris méd.*, Feb. 6, 1926, xvi, 127–132.

The best field for roentgen treatment is in tuberculous adenitis. There are three forms: (1) simple hyperplastic lymphomas; (2) closed lymphomas with central caseation or suppuration, and (3) abscessed glands with fistulas. In groups 1 and 3 roentgen treatment should be given in the beginning as it cures the majority of cases. Isolated and mobile lymphomas which prove resistant to roentgen therapy should be extirpated. In group 2 where there are abscesses in the center of the lymphomas they generally come to the surface on roentgen treatment and recovery follows. But caseous foci in the center are very hard to cure. Roentgen treatment should not be pushed too far in these cases, but the resistant glands should be extirpated. Recurrences and cases already operated upon should always be irradiated.

The author has collected 270 cases of lymphoma treated by irradiation: 73 per cent were cured and there was improvement in 14.8 per cent; 8.5 per cent had relapse and 3.7 per cent died of the tuberculosis or an intercurrent disease. Small doses should be used ($\frac{1}{3}$ to $\frac{1}{4}$ skin erythema dose) with 3 to 4 mm. aluminum filter, or in exceptional cases 0.5 mm. zinc or copper, given at intervals of four to six weeks. Larger doses are dangerous.

The prognosis of tuberculous peritonitis has improved considerably since the introduction of roentgen treatment. Irradiation should be given at once in plastic-adhesive cases, in cases which are inoperable because of the poor condition of the patient and in cases in which the patient refuses operation. Exudative forms should be operated on first and irradiated afterwards, though mild exudative forms may also be irradiated at once. Serious consequences may result from an excessive deep dose so some caution is necessary. Jüngling calculates the dose according to kilograms of weight, or 4, 6, or 8 fields may be used and each irradiated with a small dose, $\frac{1}{5}$ to $\frac{1}{3}$ skin erythema dose. The maximum filter should be 4 mm. aluminum, the minimum interval between treatments four to six weeks.

The results of surgery in renal tuberculosis are so good that roentgen treatment is scarcely indicated except in inoperable cases. Its only indication in vesical tubrculosis is when the renal tuberculosis, which is generally the cause of it, is bilateral and therefore inoperable.

Steppe has filled the bladder with collargol in vesical tuberculosis in order to make use of the secondary radiation from the particles of metal in suspension; but in general the indications for roentgen treatment in bladder tuberculosis are very doubtful. Surgeons in general prefer epididymectomy or castration in cases of unilateral tuberculosis of the epididymis, though roentgen treatment may be used in mild cases. Irradiation is indicated when the disease is bilateral or when after extirpation on one side the disease appears on the other.

Vogt was the first to use roentgen therapy in tuberculosis of the female genitalia; among 14 patients treated exclusively by roentgen rays 6 recovered, 3 were considerably improved, 2 died and 1 did not improve. Weibel had 82 per cent good results and 18 per cent mortality. Vogt thinks roentgen therapy is indicated in cases of tuberculous endometritis without peritoneal or adnexal symptoms, in cases where operation is contraindicated and in bilateral adnexitis. But the most important use of roentgen treatment in these cases is postoperative and the percentage of cures has been increased from 66 to 87 by its use. Vogt uses large fields and long intervals; he gives 50 per cent erythema dose while Jüngling recommends only 10 to 20 per cent.

Great care must be exercised in the roentgen treatment of tuberculosis of the larynx because of the danger of injuring the larynx; and as tuberculosis of this organ is almost always secondary to that of the lungs the prognosis depends greatly on the primary disease. The best technique is to use 8 to 10 Kienböck units with a focal distance of 24 cm. and a filter of 4 mm. aluminum over three fields, one in front and one on each side of the larynx for a week; the next week the series may be repeated and then the treatment stopped for three weeks.

In general the results of roentgen treatment are good in bone and joint tuberculosis but they are not equally good in all the joints and recovery is slow and begins with an indolent stage of long duration. So the cases have to be followed up for several years and suitable general treatment should be given in connection with the irradiation. Great care must be used in dosage as lesions, not only of the soft parts but also of the bones, may be caused by relatively small dosage, particularly in the lower limbs. Not more than 20 to 30 per cent skin erythema dose should be given, or in very deep lesions 40 to 50 per cent, less in children than in adults. Among the forms of bone tuberculosis the one that gives the best results in roentgen treatment is spina ventosa. Costal tuberculosis is often the starting point of tuberculous pleurisy and therefore roentgen treatment is rather dangerous; light baths are to be preferred. In tuberculous spondylitis the time required for cure is often greatly shortened by roentgen treatment, and the same is true of sacroiliac tuberculosis. Roentgen treatment is to be preferred to surgery in tuberculosis of the wrist and joint and operation should be almost entirely given up in scapulo-humeral tuberculosis. The results of roentgen treatment are not so good in tuberculosis of the knee and ankle; there are often recurrences which have to be operated upon finally. This is possibly due to the poorer circulation as compared with the arm, and possibly to the irritation from walking.

FERROUX, R., MONOD, O., and REGAUD, CL. Treatment of cancer of the neck of the uterus by radium at a distance; technique and first results. *J. de radiol. et d'électrol., Par.*, January, 1926, x, 21–23.

The authors now have 4 gm. of radium available. They at first used it at a distance of 6 cm., then of 8 cm. and now of 10 cm. The frame for carrying the radium is supported by a modified roentgen tube stand. The frame is a rectangular plate 11 × 14.5 cm., entirely covered by 80 tubes each containing 50 mg. radium. The gamma radiation is filtered through the equivalent in platinum and brass of 1 mm. platinum. Protection is by 2 cm. lead. The distance from the skin is maintained exactly by a localizing tube of wax lined with 1 cm. lead interposed between the radium and the skin, the opening of which, closed by a plate of wax, is moulded to the part to be irradiated without the weight of the apparatus resting on the patient. There are 2 to 7 portals of entry which may be anterior iliac, sacro-iliac, lateral ilio-femoral or vulvo-perineal, depending on the localization and volume of the tumor to be treated. The doses which at first were 500 millicuries have now been increased to as high as 2 curies. The time of treatment has now been reduced to 12–15 days with one or two treatments a day.

Since August, 1924 they have treated 32 patients with cancer of the cervix, 26 of them absolutely inoperable; sometimes the above treatment was used alone, more frequently it was combined with utero-vaginal radium treatment. Of course it is too soon to report final results, but the work so far has shown that the organism can tolerate large doses of gamma rays filtered through 1 mm. platinum, distributed over a large pelvic field better than it can roentgen rays even if filtered through 2.5 mm. zinc. Most of the patients had only very slight objective and subjective symptoms belonging to the syndrome caused by penetrating irradiation. There were transitory changes in the blood which are being studied. Seven

patients showed slight and temporary digestive disturbances, colic, diarrhea, nausea, which seemed to begin about the time the treatment was shortened and the dose increased. No signs of infection were seen, which indicates that this method decreases the resistance of the tissues to infection less than other methods of irradiation. There were slight skin changes, erythema, pigmentation, dry desquamation when treatment was given at a distance of 6 cm. but no such changes have been seen since the distance was increased to 10 cm. The effectiveness of gamma irradiation is proved. Cancerous infiltrations of pelvic connective tissue which do not yield to utero-vaginal radium therapy because of their superficial localization, disappeared entirely. Among 22 cases treated the first year 16 show no signs of cancer. As the limit of tolerance of the tissues has not yet been attained with the present dosage the results will doubtless improve as the maximum dosage is determined.

GAYET, G., and PEYCELON, R. Treatment of cancer of the prostate. *Arch. franco-belges de chir.*, Sept., 1925, xxviii, 759–781.

From 1912 to date the authors have observed 106 cases of cancer of the prostate. They exclude the cases from 1912 to 1914, performed in the early days of radium therapy before the technique was well developed, and those treated in 1925 as being too recent. This leaves 71 cases, in 33 of which it was impossible to do more than give palliative treatment because of the advanced stage of the disease. The other 38 were given radium treatment. They used tubes of 49 to 50 mg. containing 53 per cent radium element; they almost always used two tubes simultaneously; in 14 cases they left the tubes in place twenty-four hours, but since 1921 they have irradiated for forty-eight hours in 23 cases. In the beginning the total dose was 9 millicuries; since 1921, 18 mc. and in some cases of repeated treatments 27 or even 36 mc. In the majority of cases they used the perineal route, puncturing with a trocar by Marion's method; in 14 cases they used the hypogastric route, the tube being placed in contact with the tumor after cystostomy or placed in the bed of the prostate after enucleation of the gland. In 7 cases they used the rectal route, with triple filtration through tubes of platinum, silver and rubber. They used the urethral route in only 3 cases. They never implanted needles directly in the tumor after perineal incision and exposure of the prostate. In one case they implanted 6 needles in the floor of the bladder after hypogastric section and left them in for ninety-six hours; the result was bad and the cancer continued to progress. In 8 cases they performed transvesical prostatectomy before using radium.

Among the 38 cases treated 15 have disappeared since the year following the treatment and nothing is known of them. Nineteen are dead; 4 of them survived the treatment less than a month; 5 for two months; 3 for four to six months; 2 for ten months; 3 for a year; 1 for eighteen months; 2 for twenty months and one for twenty-nine months. Four are still living; in 2 cases it has been six months since the treatment and in 2 ten months. From these results the authors have decided to give up radium treatment in operable cases. Surgical removal of the tumor is the treatment of choice. The prostatectomy should be total and extracapsular, removing in one block the prostate and seminal vesicles, the beginning of the vas deferens and the neck of the bladder as well as the fibrous walls of the aponeurotic bed of the prostate. The only hope of better results is to make an early diagnosis while the cancer is still limited to this zone which can be removed. As soon as this limit is passed surgery is no longer effective and radium may be tried with a view to cutting off the lymphatic routes by which the cancer is spread. In the period of invasion of the bladder or of prostato-pelvic cancer radium is contraindicated. The only thing that can be done is to perform palliative operations, such as cystostomy which relieve the patient's suffering and prolong his life somewhat. Radium in these cases may cause rapid metastasis or serious intoxication in addition to violent pain.

GUNSETT, A. Cancer of the bladder and deep roentgen treatment, *J. de. radiol. et d'électrol., Par.*, January, 1926, x, 14–20.

Cancer of the bladder is generally so malignant and operative mortality so high that an attempt at roentgen treatment is completely justified. The author gives the clinical histories of 11 cases treated by roentgen therapy. In 6 of them he succeeded in bringing about complete disappearance of the bladder tumor, which in some of the cases was very extensive. In one case the treatment was postoperative after extirpation of the tumor. The other 4 cases were failures. Among 6 cases in which the tumor disappeared 2 of the patients have died. One of them died of a rectal tumor which was independent of the bladder tumor and one died of an intestinal disease the nature of which is not entirely clear, but the bladder tumor did not recur. Among the other 4 cases, 2 are recent, one dating from March, 1922; this patient is free of recurrence after three years and is working at his trade as a house-painter. The other

operation was in the beginning of 1923 and the patient is still in perfect condition.

The results of deep roentgen therapy of cancer of the bladder are therefore not important and the best course to follow is in cases which are still operable by partial cystectomy to operate, followed by postoperative roentgen treatment. If the tumor is inoperable roentgen treatment is indicated. This might be advantageously combined with radium treatment, the radium tubes being introduced by means of a cystoscope or a Nélaton catheter. This is the method which the author intends to follow in cases resistant to roentgen treatment.

HERNAMAN-JOHNSON, F. The treatment of rodent ulcer. *Lancet, Lond.*, Feb. 20, 1926, i, 389–391.

The treatment of choice in the case of "virgin" rodent ulcers is radiation therapy. Clinical experience leads the author to believe that concentration of roentgen-ray dosage may give good results in many cases, and the method is a convenient one; but it affords no guarantee against recurrence. Radium treatment suffers from the same disadvantages. Not only do recurrences appear with any form of radiation treatment, but as a rule the tumors yield slowly if at all to further application of the same type of radiation. On the other hand, a method which is in essence stimulative, such as the so-called ionization with zinc, may effect a cure. In the case of a recurrence, rays of a different wave length from those originally used should be employed. If improvement is not manifest within a month, some method of resensitizing the tissues, as by curettage or ionization, should be resorted to, after which radiation may again be given a trial.

If the above methods do not produce definite and continuous improvement at the end of two months, the diathermic cautery should be employed. This method owes its success not merely to destruction of cancer cells, but to the sharp reaction produced in the surrounding tissue. If all recurrences are dealt with promptly there should be no need for surgery in the ordinary sense of the term. When, however, the recurrence has already assumed large proportions it may be necessary to invoke the aid of the plastic surgeon to make good what has been destroyed.

HOLMES, GEORGE W. The present status of radiation therapy in carcinoma. *Boston M. & S. J.*, Aug. 26, 1926, cxcv, 399–405.

The effective treatment of carcinoma requires the cooperation of a group of physicians trained in the various specialties and particularly interested in this disease. Each case should be carefully studied and a definite plan of treatment decided upon before starting any single form of therapy.

Most curable cases are better treated surgically, but the surgeon should not attempt a radical cure where complete removal of the tumor is impossible. These cases are better treated by irradiation alone. Pre-operative irradiation properly used probably increases the chance of surgical cure. Postoperative irradiation has failed to prevent recurrrence, and when prolonged has caused permanent damage to the skin. In the treatment of recurrent and inoperable cases, relief of the distressing symptoms should be the main object of the treatment. It is usually inadvisable to use heavy or prolonged doses in an attempt to control the condition.

MARTINEZ, FIDEL F. Roentgenotherapy of cancer of the stomach. *Paris méd.*, Jan. 9, 1926, vi, 46–51.

Theoretically cancer of the stomach should be amenable to roentgen-ray treatment. Cells are more susceptible to the action of the rays the greater their karyokinetic activity, and the less differentiated they are, that is the more they approach the embryonic type. The karyokinetic activity of stomach cancer cells is very great and they are only slightly differentiated anatomically and functionally. The difficulty lies in determining the exact distance of the cancer from the skin and its exact extent and in administering the dosage accurately. The method of cross-fire must be used in order to give a sufficient dosage at the depth of the tumor without destroying the skin, and hard rays must be used. Cancer of the pylorus and the anterior surface are much more accessible than those of the cardia which are lost under the arch of the diaphragm.

The author uses the technique of Friedrich, Warnekros and Chaoul. The patient is placed in a comfortable enough position so that he can remain without moving through the long treatments. An abdominal compressor is used to shorten the distance from the skin to the tumor. The parts which are not to be exposed to the rays are protected with leaded rubber and the necessary precautions are taken to protect the patient from high tension electric currents. Generally four fields are necessary, two in front and two in the back; sometimes five or six are necessary and occasionally two are sufficient. During the treatment opium, scopolamin and atropin are given to quiet the tendency to vomiting and roentgen sickness which almost always appears during intense irradiation and is worse in irradiation of abdominal cancers. He uses the radiosilex apparatus of Koch and

Sterzel of Dresden, which with a Lilienfeld tube, 100,000 volts and 8 ma., filtered through 8 mm. aluminum, and with 30 cm. focus-skin distance gives an erythema dose in twenty-two minutes and carries 35 per cent of the superficial dose to 10 cm. depth.

The results have been very unsatisfactory. In many cancers of the liver, stomach and intestine there has been no favorable reaction while several others have been improved or even apparently cured, but within a few months there has been recurrence with unusually rapid invasion and death.

But there is no such thing as medical treatment of cancer of the stomach, surgical treatment is extremely unsatisfactory and the most hopeful plan of action seems to be to try to improve the technique of roentgen treatment until it fulfills its theoretical possibilities.

MELDOLESI, GASTONE. Treatment of some skin cancers. *Arch. di radiol.*, Jan-Feb., 1926, ii, 80–81.

Three ulcerated epitheliomas of the skin were treated by a special technique. One of the patients had a tumor of the nasolabial fold, another of the right ala nasi. They were almost round and about a centimeter in diameter. They were slightly infiltrated and had an ulcer in the center covered with a serohemorrhagic crust. In each case the surface of the neoplasm was covered accurately with a disc of lead 2 mm. thick, and a secondary filter of gauze, so that the protection just exactly covered the tumor. Irradiation was then given over a surrounding skin field 6 × 8 cm., the eye and hairy part of the skin being covered. The dose was a little more than a skin erythema dose and variously filtered, ten minutes without filter, ten minutes with 3 mm. aluminum, twenty minutes with 5 mm. aluminum; skin distance 30 cm. It would seem that the direct action of the rays on the tumor would be intercepted by the lead; nevertheless twenty-five days after the treatment the lesions were completely cicatrized; in each case only a flat scar of healthy appearance remained. Since then one of the patients has been lost from sight. The other, treated in May, 1925, returned in November because a recurrence had developed two months before at the same site.

A third patient with a small chancroid a little larger than a lentil of the zygomatic region which was barely beginning to ulcerate was treated in the same way except that, the lesion being so small, the protection was extended a little way beyond it, a disc of lead about a centimeter in diameter being used. The same dose and quality of rays were used, but they did not cause the slightest change in the appearance of the tumor. No conclusions are drawn. The cases are simply reported as a suggestion for further experiments of the same kind.

NALDO, NICOLIS. Roentgen therapy of fibromyomas of the uterus with one treatment. *Arch. di radiol.*, Jan-Feb., 1926, ii, 57–70.

The author treated 30 cases from December, 1921 to November, 1923 by this method. He gives a table showing the age of the patients, the part of the intermenstrual period at which the treatment was given and the outcome with regard to cessation of menstruation and disappearance of the tumor. Twenty-seven of the patients were cured and in 3 there was recurrence, one in six months, one in eight months, and one in nine months. These patients were given another treatment and 2 were cured, while in the third hysterectomy had to be performed. In the great majority of cases the uterus remained slightly enlarged and irregular. At first the regression of the tumor was quite rapid, until it had been reduced about half and after that there was a period of slower decrease. The regression began immediately after the treatment, sometimes before amenorrhea was established and was sometimes accompanied by a copious white discharge.

He tried as far as possible to irradiate in the first half of the intermenstrual period because if the rays act at this time on a mature follicle or young corpus luteum they prevent the formation of those substances which stimulate the next menstruation, while if the irradiation is performed in the second half of the intermenstruum the hormones which stimulate the next menstruation have already been poured into the circulation and premenstrual changes have already begun more or less. Excluding the 10 cases in which it was not possible to determine the time in the intermenstrual period, among the 14 irradiated in the first half there was immediate amenorrhea in 4, or 28.5 per cent, in 7 there was menstruation only once and in 3 two menstruations, or 21.5 per cent. Among the 6 irradiated in the second half of the intermenstruum there was one menstruation in one case, or 16.6 per cent, two menstruations in 4, or 66.6 per cent and three menstruations in 1, or 16.6 per cent.

Seitz and Wintz recommend 34 per cent of an erythema dose, but the author allowed 40 per cent. He used a tube which gives a dose of 20 per cent at a depth of 10 cm. with a skin distance of 25 cm. If the ovary is not more than 10 cm. distant from the skin an anterior and a posterior field on each side are enough. In case of very large fibroids in stout women where

the ovary is probably deeper the number of fields may be increased. In general, the Germans try to act indirectly on the tumor through the ovary, while the French prefer to act directly on the tumor cells. But the author believes the difference is theoretical rather than practical and the results are about the same with the two methods.

He emphasizes the importance of being certain of the diagnosis of fibroid before giving the treatment, preferably by histological examination of material obtained by curettage, because roentgen treatment has often been blamed for causing cancerous degeneration of fibroids when as a matter of fact the tumor was probably malignant to begin with.

The signs of artificial menopause brought about by the treatment do not differ at all from those of the normal menopause. The injuries sometimes complained of in roentgen treatment of fibromas of the uterus, such as roentgen dermatitis, proctitis, cystitis, etc., are to be attributed to errors in technique rather than to the method itself and can be avoided with sufficient care. He has seen general roentgen sickness only in women who were in a poor condition of nutrition and anemic.

NEDDERMEYER, A. Roentgen irradiation of the spleen especially as regards its effect in pulmonary hemorrhages. *Beitr. z. klin. Tuberk.*, 1926, lxiii, 555–563.

Roentgen irradiation of the spleen seems to result in an artificial stimulation of the normal function of this organ. This is regarded as true stimulation by the rays, because it is argued, if the action were injurious, then an extirpation of the spleen should produce an analogous effect as regards an increase in the number of thrombocytes, whereas the opposite occurs.

The great decrease in the blood platelets following irradiation of the spleen must consequently be regarded as due to an acceleration of the normally occurring thrombolysis in the spleen. If one regards thrombolysis as the active process conditioning the clinical control of hemorrhages and the favorable effect upon the blood coagulating system, it would seem that the cause lies in a transfer of substances accelerating blood coagulation from the destroyed blood platelets to the serum. This furnishes a simple and illuminating explanation of the mode of action of roentgen rays through spleen function upon all sorts of hemorrhages, including those in the lung, both parenchymatous and cavernous.

Brief descriptions are given of the results obtained in 6 cases of pulmonary hemorrhage. The technique of roentgenization was essentially uniform, although account was taken of individual characteristics in the patients. It is admitted that the cases were carefully selected, and the author does not claim to recommend immediate roentgen treatment in cases where there has been prolonged hemorrhage, without a previous trial of other therapeutic methods.

Care was taken to have the patient lie as comfortably as possible either on the right or left side with hands extended over the head. The spleen outlines were determined by palpation, and a field 10 × 10 cm. was selected and exposed at a focal skin distance of 23 cm., the rays being filtered through either 4 mm. Al, or 0.5 mm. Zn plus 3 mm. Al. The rest of the body was carefully shielded with 8 mm. lead rubber. Assuming an average depth of 5 cm. for the spleen, a depth dose of 40 per cent of the skin erythema dose was administered to the spleen, with a Coolidge tube operated at 3 ma. for 8 min. The cases receiving splenic irradiations were kept strictly away from any treatment with hemostyptics. A single irradiation in most cases seemed to be sufficient.

SOLOMON, I., and BLONDEAU, A. Roentgen therapy of papilloma of the larynx. *J. de radiol. et d'électrol., Par.*, March, 1926, x, 112–114.

Papilloma of the larynx is seen chiefly in children from two to six years of age. Under surgical treatment the prognosis has been rather serious; tracheotomy is almost always necessary and the papillomas recur constantly, so that although they are benign they are very troublesome because of the interference with respiration and speech and because of the necessity for repeated operations.

The authors describe a case in a young man aged seventeen who had had papillomas since the age of seven; at first he was hoarse and then had progressive aphonia until at last he could only whisper. He had had four laryngeal operations in 1918 and 1919; the dyspnea increased progressively and tracheotomy had to be performed in 1920.

Roentgen treatment was commenced Jan. 14, 1925. Laryngoscopic examination at this time showed papillomas almost completely covering both vocal cords. From Jan. 14 to Feb. 11 he was given a total dose of 7000 R on two cervical fields, right and left with very penetrating rays (spark gap 40 cm.), filtered through 0.5 mm. copper and 2 mm. aluminum. A dose of 1000 R was given twice a week. Ten days after the beginning of treatment the tracheal cannula could be removed, respiration improved and laryngoscopic examination immediately after the last treatment showed great decrease of the papillomas. Fifteen days

after the last treatment his voice was almost normal. As there were still some papillomatous vegetations nine weeks after treatment a second series of irradiations were given which were not well borne and treatment was stopped after 3000 R had been given. The patient was seen in October, 1925 and is completely well; nothing abnormal can be seen but a notch in the posterior part of the left vocal cord from one of the operations. He can speak normally and even sing. One of the authors treated two patients in 1920 and 1921; their history was about the same as that of the above case. They were treated with moderately penetrating rays (100 kilovolts, filtration through 10 mm. aluminum) and the total dose of 8000 R was distributed over a period of twelve weeks. There was permament cure in both cases.

Jüngling has always been able to cure papillomas of the larynx with one roentgen treatment; he irradiates through two cervical fields and gives a dose which he estimates at 80 per cent of the skin erythema dose. He has never seen recurrence, after a period of observation of three years, nor has he ever seen any lesions caused by the rays. The authors consider roentgen therapy the treatment of choice for papillomas of the larynx as it quickly brings about permanent cure without any scars to interfere with respiration or phonation.

STOLKIND, E. A case of juvenile acromegaly with congenital aortic stenosis treated with *x*-rays. *Proc. Roy. Soc. Med., Lond.*, January, 1926, xix, Clin. Sect. 5–6.

The case briefly reported occurred in a girl aged nineteen suffering from general weakness, tiredness, etc. The roentgen examination showed the signs of early acromegaly. The superciliary areas were abnormally developed, the majority of the teeth separated, the lower jaw visibly prognathic. The sella turcica was large, and the posterior clinoid processes exhibited projections extending backward. There were large nasal sinuses and signs of acromegalic changes of the supra-orbital ridge and mandible. There were no signs of bone destruction or deformation.

The eyes were tested and found to be normal. For the past three and a half years there has been no deterioration in vision and the sella turcica has remained of the same size for three years. During this period, November, 1922, to June, 1925, five series of roentgen irradiations of the pituitary gland were given. After the last treatment the patient's condition improved. She is stronger, brighter, takes more interest in her activities. In this case there is definite evidence of improvement of the subjective symptoms after roentgen treatment. Since acromegaly is usually subject to spontaneous arrest it is difficult to decide whether the roentgen therapy was responsible in this case for the arrest in growth. (The details of the roentgen therapy are not given.)

TULLIO, G. Roentgen therapy of eczema. *Arch. di radiol.*, Jan-Feb., 1926, ii, 71–79.

The technique used was as follows: Radiagna apparatus, 60,000 volts, 3 ma., 2 mm. Al filter; dose 2 H. The 2d treatment was given eight days after the first, the 3d eight days after the 2d, the 4th two weeks after the third, the 5th three weeks after the fourth and the 6th 4 weeks after the 5th. If this number of treatments was not effective it was given up. The author's cases were all chronic and had resisted various other kinds of treatment. He believes the treatment is not contraindicated in the acute forms but that it is not generally necessary, as the ordinary methods of treatment are effective.

The total number of cases treated was 337, with 184 cures, 35 recurrences, 8 unchanged, 2 improved, result unknown in 24, and 84 still under treatment. Among them there were 46 cases of eczema of the breast, which is a particularly stubborn and intensely painful form. He had 32 cures and only 2 recurrences; 10 are still under treatment. The radiosensitiveness of the testicles is not a contraindication to roentgen treatment in eczema of the scrotum, both because of the low dose used and because irradiation of the testicles can easily be avoided. In generalized eczema he irradiated the thyroid. He had complete cure without recurrence in 2 out of 3 cases which had resisted various other treatments including organotherapy. In the keratotic form of eczema most authors recommend 8 to 10 H filtered through 3–5 mm. aluminum. But the author feels that even in these cases the action sought for is not a keratolytic one but a stimulant one on the stratum and so he only increased the dose a little, using not more than 3 H, and giving the treatments a little closer together. The results were as good as in the other forms although the treatment required a little more time.

WINTZ, H. Experiences in the irradiation of breast cancer. *Brit. J. Radiol.*, April, 1926, xxxi, 150–156.

A review of cases treated at the Erlangen Clinic confirms the facts already found concerning uterine carcinoma. Breast cancer must be treated in the initial stages to yield the best results. An analysis of 106 cases is given in Table 1. Under the heading "lost" are included all those who died whether of carcinoma or of intercurrent disease, those who could not be fol-

lowed up, and also patients who were at the point of death at the end of the three years, whether from cachexia or from distant metastases.

TABLE I

Steinthal Grouping	Patients			Clinical Cures Per Cent
	Treated	Cured	Lost	
I	21	20	1	95.2
II	41	28	13	68.2
III	44	8	36	18.1

Another analysis is presented in Table II. The cases comprising Groups I and II of the Steinthal classification are combined here in order to avoid small figures.

TABLE II

After Treatment Years	Steinthal Grouping	Patients		Clinical Cures Per Cent
		Treated	Cured	
3	I and II	62	48	77
3	III	44	8	18.1
4	I and II	47	31	65.9
4	III	36	3	8.5
5	I and II	35	17	48.5
5	III	11	2	18.8
6	I and II	28	9	32.1
6	III	10	1	10.0
7	I and II	15	3	20.0
7	III	4	..	....

As regard, Group III, the favorable percentage shown is not as a rule found in surgical statistics. The results shown under Group II are better than the average results found in surgical statistics. In Group I there is undoubtedly an ideal ground for competition between the surgical and roentgen treatments. Only the statistics of the best surgeons, however, should be taken into consideration. The author believes that if satisfactory results are to be obtained three years after conclusion of treatment, the roentgen treatment alone is not sufficient.

The author is no longer of the opinion that prophylactic treatment should be given soon after operation. One should wait until nodules on the skin or gland metastases give pronounced indications for treatment. If no such indications occur, the author waits six to eight months after operation and then administers a dose of 90 to 100 per cent of a skin unit to the whole region involved. It happens not infrequently that shortly after operation and in consequence of it, the cancer is spread through the body by the circulation and that metastatic nodules and vertebral metastases develop. If, in fact, such infection has taken place, then roentgen treatment is useless and the patient dies of multiple metastases whether treated by roentgen rays or not. One might object that the period of waiting until symptoms of secondary deposits appear might be dangerous, because in that time the cancer cells might have opportunity to spread and because recurrences or metastasis might be so slight that the usual methods would not suffice to disclose them. Whether these objections are justified remains to be determined.

WINTZ, HERMANN. Experience with the roentgen treatment of carcinoma. *Strahlentherapie*, 1926, xxi, 368–379.

In carcinoma therapy two different aspects should be considered: one is the roentgen irradiation which is intended to destroy the carcinoma cells; and the second is the treatment of the carcinomatous individual, which has two aspects, namely, (*a*) the local treatment at the site of the carcinoma, and (*b*) the general treatment of the whole body. The destruction of the carcinoma cell by roentgen rays is a physical problem which is of course guided by medical knowledge. The local and general treatment of the body is a biological problem involving primarily reconstruction.

In the irradiation of carcinomas, the author has always aimed to administer the full dose at one sitting and has used divided doses only when the apparatus available did not permit administration of the full dose. Division of a certain dose over a period of several days means a diminution of the biological effect. The latter statement may now be regarded as a law because it has so often been demonstrated that its truth can no longer be doubted. The best example of this is the castration dose. If the dose of 34 per cent of the skin unit is administered over eight days instead of at one sitting, one finds that ovarian function is not eliminated. It is only when the eight day dose is increased to 50–52 per cent of the skin unit that an effect is obtained equal to that of a single application of 34 per cent of the skin unit.

Local treatment is to be employed only in very special cases. Experience has shown that in general, the irradiated tumor should be allowed to regress without disturbance. Irritation should be avoided and experience has likewise shown that inflammations must be controlled if a successful treatment of the cancer is to be hoped for. The author believes that electrolysis and cataphoresis to produce a deep antisepsis with copper is a valuable aid.

General treatment of carcinoma should support reconstruction and restitution. Although there is no single means that can be

recommended without reserve, the employment of arsenic and general clinical factors for improving the bodily condition are very important. Residence at high altitudes appears to be an adjuvant to roentgen therapy that should not be overlooked.

Recent experience shows that 15 per cent of cases of carcinoma appear to succumb to the disease despite the most favorable conditions to cure, such as early diagnosis, early treatment, excellent physical condition of the host, etc. For the present we possess no prognostic signs which will detect these individuals in whom apparently a dissemination of the carcinomatous condition occurs almost simultaneously with the appearance of the local tumor. It is evident, therefore, that one cannot expect 100 per cent cures and that the limit should lie at 85 per cent. The major portion of the cases treated by the author were cases of carcinoma of the uterus, 800 of the cases having been observed five years after conclusion of treatment. By deep roentgen treatment and accompanying after treatment about 60 per cent of operable carcinomas of the portio vaginalis can be controlled; and in inoperable cases the number was from 10 to 14 per cent five years after completion of treatment. For the whole series this corresponds to an absolute cure of about 20 per cent.

The radiation treatment of mammary carcinoma does not show up so favorably at present as the radiation treatment of carcinoma of the portio vaginalis, and there are authors who deny the right of the roentgen therapist to treat operable mammary carcinoma exclusively with roentgen rays.

A summary is presented of the three-year cures after exclusive surgical treatment in various clinics. These show 68 to 100 per cent cures in Group I, 19 to 43 per cent in Group II and 0 to 29 per cent in Group III (the groupings referring to the Steinthal classification of mammary carcinomas). The author obtained 95 per cent three-year cures in 21 cases in Group I; 68 per cent of 41 cases in Group II and 18 per cent of 44 cases in Group III. Combining Groups I and II he obtained 77 per cent three-year cures, 66 per cent four-year cures, 49 per cent five-year cures and 32 per cent six-year cures. The figures given include all the cases without subtraction of those dying of intercurrent disease. If the latter had not been included the five-year cures would have amounted to 63 per cent. The author is no longer sure of the value of irradiation promptly after operation in mammary carcinoma. It appears more advisable to wait for five or six months after operation to administer postoperative roentgen treatment or when a skin metastasis indicates the need for it. This opinion seems to be confirmed by the author's statistics. Prophylactic treatment after a radical operation yielded 57 per cent of three-year cures, while the primary irradiation of mammary carcinoma in Groups I and II of Steinthal yielded 77 per cent.

There is at present no longer any doubt as to the justification for an exclusive irradiation of carcinoma of the uterus with roentgen and radium rays. As regards mammary carcinoma, the conditions are much more complicated, while in uterine carcinoma the primary mortality is very high and the end results from operation are less satisfactory, we find on the other hand, in early mammary carcinoma the operative mortality is extraordinarily low and the permanent results obtained by all prominent surgeons are quite excellent. Consequently if roentgen therapy is to compete with operation the permanent results attained by surgery would have to be equalled at least. The author has indicated that exclusive radiation therapy of mammary carcinoma in operable cases can be made to yield the desired results. There is need, however, for a more extensive series of cases before the fact can be considered demonstrated.

MISCELLANEOUS

SIEVERT, ROLF M. A portable instrument for the measurement and registration of *x*-ray intensity. *Acta radiol.*, 1925, iv, 129–132.

A description is given of the instrument which consists of a large ionization chamber, a galvanometer and a compensation arrangement. This registering device can be affixed to the roentgen machine. A photographic apparatus can be placed in front of the galvanometer and the readings thus recorded. The accuracy with which the intensity of roentgen radiation can be determined by means of the instrument is from 1 to 2 per cent at 4 ma. and 180 kv. The accuracy becomes still greater with increased intensity of radiation.

SCHWARZ, GOTTWALD. On the problem of latency and rhythmicity. *München. med. Wchnschr.*, Oct. 30, 1925, lxxii, 1867–1869.

In a study of the nature of the latent periods and the rhythm of erythemas following roentgen treatment, the author has discovered that mustard oil produces very analogous phenomena. (It was observed incidentally, that mustard oil is also one of the most effective agents for increasing radiosensitivity). This phenomenon of latency and rhythmicity in the effects of mustard oil can be readily carried out on any individual. The curve of latency and

erythema after mustard oil application is completed in a matter of seven hours, while the analogous curve after roentgen treatment is a matter of seven weeks, but the parallelism is striking.

Mustard oil experiments show two separate waves of erythema; the first one appears after a latent period of about five minutes after application of the oil and lasts about one and a half hours; then follows a second latent period of four hours, followed by a secondary erythema lasting twenty-four hours and followed by pigmentation. The primary erythema is undoubtedly due to the direct action of the toxic substance. This reaction must be regarded as the expression of a defense process in which the toxic product is changed. The fact that this primary erythema lasts for one and a half hours would indicate that it is not a simple "reflex" erythema.

For an explanation of the secondary erythema we must assume that the detoxified material has not been removed and has produced further changes which require a much longer time to develop, i.e., a process having a "low reaction velocity." A similar stepwise reaction is observed in the von Pirquet allergic test with tuberculin. A comparison of these chemo-reactions with reactions following irradiation shows a considerable analogy between the primary roentgen erythema and the secondary mustard oil dermatitis. In both cases the effect is produced within and by the living substance with a slow development and a very gradual inflammation which explains in both cases the latency lasting several hours. It is much more difficult to explain the second latent period lasting several weeks in the case of the roentgen reaction. It may be that in this case the development of a tissue allergy is necessary, and this requires the prolonged latent period.

If the above explanation is accepted it would appear that there is no essential difference between the chemo- and allergo-reactions of the skin and the reactions produced by roentgen and radium rays.

SCHWARZ, G., CZEPA, A., and SCHINDLER, H. Newer studies on the effect of roentgen rays upon plants. *Strahlentherapie*, 1925, xx, 210–212.

A previous investigation of the authors upon tens of thousands of specimens of wheat and flax seedlings had definitely shown that there was no stimulative action of the roentgen rays upon their growth. A recent work by Ivens who studied nine different varieties of plant found affirmatory evidence of a possible stimulative action in the case of *Vicia faba*. The present authors had already tried this plant and discarded it because of unsuitability. The main objection to its use is the fact that the normal variability in the growth of seedlings of this plant is extraordinarily great. An illustration is given showing the differences in size and development of seedlings from seeds of exactly the same weight and grown under exactly the same conditions. An effort will be made to subject this plant to a careful analytical study and determine if a roentgen stimulation can actually be produced in it.

A secondary stimulatory effect in the animal organism through vasodilatation and inflammatory response to roentgen rays has been claimed by G. Schwarz to be the mechanism in animal tissues exposed to the rays. This circulatory disturbance and inflammatory reaction cannot of course take place in the plant.

SMALL, JAMES C., EVANS, MARY J., and KRUMBHAAR, E. B. Studies in biological resistance to malignant tumors. III. The effect of a single injection of irradiated sarcoma cells upon the growth of established homologous tumor grafts. *J. Cancer Research*, September, 1925, ix, 316–322.

An attempt was made to duplicate, as far as possible, the experimental conditions employed by Chambers, Scott and Russ on the Jensen rat sarcoma, except that the present authors used the experimental rat sarcoma No. 10 of the Crocker Institute. It was found that the growth of the established tumors was not affected by a single injection of homologous tumor cells devitalized by roentgen irradiation. It may be that the tumor employed does not lend itself favorably to the production of immunity responses.

It is believed that if immunity to tumor growth following injections of homologous tumor tissue devitalized by roentgen rays is to become productive of any practical benefits, it should have been manifest under the conditions of these experiments. The success of this method in other hands emphasizes the need for repeated experiments with large numbers of animals and with other types of experimental tumors.

SMALL, JAMES C., EVANS, MARY J., and KRUMBHAAR, E. B. Studies in biological resistances to malignant tumors. IV. The effect of multiple injections of irradiated sarcoma cells upon the growth of established homologous tumor grafts. *J. Cancer Research*, September, 1925, ix, 323–328.

The growth of established tumor grafts of rat sarcoma No. 10 was not affected by three injections, at weekly intervals, of homologous

tumor cells devitalized by roentgen irradiation. The results obtained by the authors are not in agreement with those of the English workers, Chambers, Scott and Russ. It is believed that the differences in results may be due perhaps to the frequent remissions that are known to occur with Jensen's rat sarcoma; perhaps also to the conditions of the present experiments, which may have been too heavily "loaded" to permit the demonstration of an existent, though weak increase in resistance; or perhaps to a combination of these factors.

Smith, Alan Def. The pathology of joint tuberculosis in its earlier stages. *Arch. Surg.*, March, 1926, xii, 740–759.

Of a series of 23 cases of joint tuberculosis in which it could be determined where the disease began, 17 were primary synovial and 3 primary bone lesions. In 3 other cases the disease probably started in the bone. It is believed that the disease starts in the synovial membrane in the majority of cases, in the knee and probably in other joints as well. The course of the disease was slower and more insidious in the synovial cases than in those with bone lesions. Whenever a bone lesion was present it was easily recognizable in the roentgen-ray examination. No instance was found in which the disease was confined to an epiphysis, although there were 3 in which it started in the metaphysis. Conclusions as to what tissue is first diseased in joint tuberculosis based on much of the material studied in the past are open to question because of the advanced stage of the cases from which the material was obtained.

In the 6 cases in which the bone was involved the history was of comparatively short duration as compared with the synovial cases, and the roentgenograms gave unmistakable evidence of bone lesion at once.

Solomon, Iser. On the choice of a quantimetric unit. *Strahlentherapie*, 1925, xx, 642–650.

The ionometric method constitutes by far the best method for determining the quantity of roentgen radiation. It may now be stated with assurance that the quantity of radiation can be expressed in physical terms which are independent of the operator, and (within important limitations) also independent of the measuring apparatus.

It is a matter of regret that the German Radiological Society adopted the electrostatic unit R (Behnken) for the measurement of roentgen-ray quantity. Another unit with the same designation but of different magnitude and different mode of measurement was already widely in use in France and other countries. This is the unit R (Solomon) which is standardized against a known quantity of radium, and corresponds to less than half of the Behnken unit (1 German R = 2.25 French (Solomon) R). For instance a dose of 3000 French R is safe, while 3000 German R can cause severe lesions. It would seem necessary in order to prevent possible confusion that the standardization of the German R be made with an ionization chamber of larger volume or else that radioactive preparations be eliminated in the standardization of the French R. A comparative study for this purpose would be of considerable utility and would promote the establishment of a satisfactory and definitive international dosimetric standard.

Sponsler, O. L. *X*-ray diffraction patterns from plant fibers. *J. General Physiol.*, Nov. 20, 1925, ix, 221–233.

The finer structure of the cell wall of the plant fibers was anticipated years ago in the theories of Nägeli, Strasburger and others but the actual existence of the lattice arrangement of structural units was not definitely established until roentgen-ray methods were applied to the problem. Several years ago roentgen-ray diffraction patterns were obtained from plant fibers and a space lattice was computed from the data thus made available. In an attempt by the author to confirm the conclusions of the earlier investigators, Herzog and Jancke, certain discrepancies led to an intensive study of the diffraction patterns. A different method was used and more than twenty new lines were found on the photographs while some of those previously reported were missing. This lack of agreement re-opened the field for further investigation.

The studies here reported were made upon ramie fibers, using the Hull technique for producing roentgen-ray diffraction patterns. Certain planes run lengthwise of the fiber and others are at right angles with the long axis. The structural units in the wall of the fiber are shown to form a space lattice, the elementary cell of which is an orthorhombic structure. Comparatively little can be said as yet concerning the structural unit. It is very probably composed of a group of atoms which are more or less closely packed together.

The data here obtained of the positions of the planes in the wall of the fiber form the basis for determining all the dimensions of the elementary cell and the size and character of the structural unit. Work along these lines is now in progress.

STENSTRÖM, W., MATTICK, W. L., and SCHREINER, B. F. A practical method for applying *x*-rays 120–150 per cent of the skin dose to the tumor without injury to the skin. *Acta radiol.*, 1925, iv, 347–356.

By using three adjacent triangular fields it is possible to concentrate more than 100 per cent of the erythema dose into a tumor 3 to 5 cm. beneath the skin without injuring the skin; and a procedure is described whereby as much as 150 per cent of an erythema may be given to a tumor 3 cm. under the skin, with just an erythema dose delivered to the skin.

The skin surface above the tumor is divided into six triangles meeting at a point on the skin just above the center of the tumor. Three of the angles at this point are made equal to 100°, with intervening angles of 20° for the other three triangles, which thus separate the large ones from each other. The large triangles constitute the fields and the smaller ones designed to prevent overlapping of the roentgen-ray beams until at such a depth that the summation of their intensity will be too low to injure the healthy tissue. In order to protect the skin in the center and the tissue above the tumor, a small copper disc is fastened with adhesive plaster to the skin above the tumor.

Each large triangular field is irradiated separately, during which process the rest of the surface area is protected with leaded rubber. The beam of roentgen rays is directed at a certain angle toward the skin. This angle is determined by the distance of the tumor below the skin surface and the widest diameter of the tumor. The size of the central copper disc is determined by the depth of the tumor and the angle of the roentgen beam. The thickness of the copper disc should be such that it absorbs somewhat less than 50 per cent of the rays in its center and the copper should be thinner toward the periphery. The authors usually use a disc 0.25 mm. thick at the center tapering down to 0.1 mm.

Three cases are cited showing the use to which the three triangular field method can be put and the results that may be expected. Such a method permits the therapist to vary his technique of application to the best advantage. The first case was an adenocarcinoma of the nose and antrum which responded to the roentgen treatment successfully. The second was a case of epithelioma of the left inner cheek which had been operated on and showed tendency to recurrence. This was an advanced case but the method of treatment above described has yielded an excellent result thus far (eight months).

The third case was a carcinoma of the left breast. This case presented metastases in the axilla and was submitted to the above method of treatment. The result has been a gradual decrease in the size of the nodules and distinct improvement. This patient is still under observation.

STAUNIG, K. General aspects of the problem of roentgen therapy. *Wien. klin. Wchnschr.*, Jan. 15, 1925, xviii, 92–94.

The effect of roentgen rays upon the living organism is essentially the production of electrochemical potential differences in the osmotic systems comprising the body. Such potential differences must arise, for instance, when a tumor or its surroundings are irradiated. In either case we find changes produced by the roentgen rays.

It is suggested, therefore, that these potential differences should be studied experimentally with the exact methods of chemistry. Such studies will permit a decision as to which method of irradiation in any particular case is the most desirable. Such studies will also reveal why roentgen rays appear to heal in one case, to irritate in another, and to produce injuries in a third. "Health" is a state of electrochemical equilibrium; it can be restored by roentgen rays in some cases; and in others the disequilibrium may be upset still further by irradiation.

STEPHENS, J. G., and FLOREY, HOWARD. An investigation of the immediate effects of *x*-rays on living animal tissues. *Brit. J. Exper. Path.*, December, 1925, vi, 269–275.

An intact unanesthetized rabbit was irradiated for seven hours with a glass roentgen tube employing 2 ma. and 12 cm. spark gap, the target skin distance being 13 cm. The exposure was interrupted for a few minutes at intervals of about a quarter of an hour. No part of the animal was protected, a layer of cardboard 0.5 mm. thick (the bottom of the box containing it) alone intervening between the animal and tube. At the end of this irradiation, blood was collected from the ear vein and tested to determine if a depressor substance appeared in the circulation as a result of irradiation. The result was negative. Various other experiments were tried to reproduce the fall in blood pressure observed by Swann following roentgen irradiation. No such change could be found.

Alteration in respiratory rate during prolonged irradiation has been reported but the present experiments were unable to verify this statement. It is suggested that the previous results may be explicable as due to electrical leakage and not to the action of roentgen rays.

A description is given for technique for the insertion of abdominal windows in experi-

mental animals. Through these windows no changes could be observed in the spleen or other abdominal viscera as a result of roentgen irradiation.

The possibility is suggested that ultraviolet fluorescence excited within the tissues by roentgen rays may be the mechanism operating in the production of effects by roentgen rays.

STUMPF, PLEIKART. Spectral studies of commercial screens. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 731–732.

Examination was made of the four types of screen represented by the following makes: (1) Heydenfolie; (2) Patterson screen; (3) Heyden-Ossal screen; (4) barium platinocyanide screen. Spectrographs were taken of the emission of these screens when excited by a Müller DD tube, the beam passing through a slit 2 cm. wide. The roentgen tube was operated at 2.5 ma., 12 cm. spark gap, duration of exposure 20 min. The spectrograms were taken with a Steinheil quartz spectrograph. Agfa-ultra-special plates were used. The lines on a copper arc were taken after each exposure for purposes of orientation.

It was found that the Heydenfolie gives off only blue light of 5000 to 3600 A, with a broad maximum at about 4200 A, there being no sign of ultraviolet light emitted. This is of importance since photographs can be easily taken with the ordinary optical glass system.

The Patterson screen showed a large narrow zone between 5700 and 4200 A and a pronounced maximum between 5100 and 4800 A. The light produced is a greenish-blue. There appears to be also a certain amount of red light which does not show on the photographic plate.

The Ossal screen has an extraordinarily narrow spectrum lying between 5500 and 5100 A, and may be regarded as emitting a monochromatic light of yellow-green color. The same spectrum, but of somewhat lower intensity, was produced by the barium platinocyanide screen.

These observations indicate that the calcium tungstate screen is most desirable for photographic purposes while the zinc silicate type and the Patterson screen will compete with each other for roentgenoscopic purposes.

TIMMER, H. The haziness of the roentgen picture. *Fortschr. a. d. Geb. d. Röntgenstrahlen*. 1925, xxxiii, 769–774.

The haziness of structure of skeletal parts becomes a disturbing factor when these parts are located some distance from the film. This occurs, for instance, when the distance permits the bone canaliculi to cast only half shadows; in other words, a distance greater than the length of the total shadow cone produced by the canaliculi. The ratio of this object-film distance to the focal distance of the end of the primary shadow cone is equal to the ratio of the size of the object to the size of the focus.

Two roentgenograms of a section of the upper end of the femur at 0 and 10 cm. distance from the film and with a 60 cm. focus film distance show the following: The roentgenogram of the bone section laid upon the film gives a beautiful picture of the bone structure, whereas the structure is entirely misleading when the bone is held 10 cm. from the film. This illustration is instructive and teaches caution in the interpretation of bone structures in the roentgenogram where the bone is some distance away from the film.

In the latter case the employment of greater film focus distances (for instance, 2 meters and more) would correct the haziness. This is illustrated by a roentgenogram of the same bone section mentioned above which was placed 10 cm. from the film but was exposed with the focus 1.5 meters distant from the film.

A small focus and a large focal distance are therefore capable of reducing the haziness of roentgenographic pictures to a minimum. The Potter-Bucky diaphragm has no effect on the haziness.

TIMMER, H. A simple method for determining the size of a roentgen tube focus. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 780.

A small lead plate with a 5 mm. hole was placed directly below the focus at a distance of 25 cm., the focus being 50 cm. from the film. The tube was operated at the ordinary voltage for roentgenograms since it is known that the size of the focus increases with the voltage. The size of the picture produced was 13 mm. The focus was calculated from the data as follows: $13 - (2 \times 5) = 3$ mm.

These calculations are based on a geometrical analysis which shows that the diameter of the focus is equal to the diameter of the shadow minus twice the diameter of the hole in the lead screen producing the shadow, provided the lead screen is situated midway between the focus and the film.

A similar method has been described by Goalwin but is claimed to be not so simple as the above.

VAN DESSEL, ARTHUR. Behaviour of sequestra in chronic osteomyelitis. *J. Bone & Joint Surg.*, January, 1926, viii, 194–206.

Staphylococcus pyogenes aureus and *albus* obtained from blood or pus in acute osteomyelitic cases were grown, and a colony of

these bacteria was embedded in agar. A piece of rabbit's bone 10 mm. long and 4 mm. wide was boiled for an hour and used as an artificial sequestrum. Under aseptic conditions a hole was drilled into the metaphysis or near the upper end of the diaphysis of the tibia or femur of a young rabbit, the sequestrum and a colony of bacteria laid in, the periosteum sewed over, and the skin closed in several layers with a final sterile dressing. Weekly roentgenograms were taken to follow up the behavior of the artificial sequestrum.

A typical picture of osteomyelitis may be obtained by this method. The first roentgenographic signs appear eleven days after operation. There are some areas of destruction seen in the cortex. Later on the destruction progresses gradually, the periosteum is elevated, the marrow cavity is obscured, the bone has a "spotty" appearance, infection spreads through the entire bone, a part of the shaft sequestrates, and under the periosteum a layer of new and dense bone appears. Various degrees of osteomyelitic processes have been thus obtained. Three examples of these rabbit experiments are described in detail.

There is a great difference between the variation of osteomyelitis produced by chemical means in which there is re-incorporation of the old dead bone, and in osteomyelitis due to bacteria and their by-products. The absorption of foreign material (artificial sequestrum) is extremely slow as compared with the absorption of artificial sequestra (bone graft) under sterile conditions. These latter, as seen in control animals, disappear completely after about six months, being adherent to the endosteum during the interval. Infected sequestra are slow to disappear. In the presence of very mild infection, eleven months is necessary; in severe infection the sequestrum was still present, slightly eroded only, after fifteen months even in practically closed infections—meaning by closed infections that there were no sinuses present for a very long time. When sinuses persist there is a continual discharge of pus and an elimination of small sequestra. An important fact is the presence of bacteria in the foci of osteomyelitis even when all sinuses are closed for at least three months. These organisms are of very low virulence and unable to reproduce osteomyelitis in other rabbits.

It is impossible by roentgenograms alone to determine whether the sequestrum is or is not completely separated. The zone of demarcation between the sequestrum and the involucrum, dead or alive, persists histologically until complete disappearance of the sequestrum. If it is really free it must either be absorbed or expelled; it never unites with new or old bone.

A caution is entered against too many conclusions being drawn from these animal experiments, which merely show that nature uses many ways in getting rid of foreign bodies. Sterile bone (grafts) and infected bone (sequestra) both disappear in roentgenograms, but when examined microscopically the processes by which this disappearance is brought about are seen to be different.

WEATHERWAX, J. L., LEDDY, E. T., and MORRIS, H. H. Studies in biological resistance to malignant tumors. 1. The determination of the "Rad" dose of roentgen ray for sarcoma cells (Crocker rat sarcoma No. 10) exposed *in vitro*. *J. Cancer Research*, September, 1925, ix, 298–304.

The "Rad" is the name used by Chambers, Scott and Russ for the minimal dose of roentgen rays necessary to prevent the growth of the Jensen rat sarcoma when subsequently inoculated into normal rats. The present authors have established the minimum lethal dose for the rat sarcoma No. 10 of the Crocker Institute, using the methods of Chambers, Scott and Russ. This minimal lethal dose is a roentgen equivalent to that obtained from the following factors: 6 in. spark gap or 84 kv., 4 ma., 26.5 cm. target skin distance, no filter, 24 min. exposure. This biologically determined value is 75 per cent of the "Rad" dose used for the Jensen rat sarcoma as determined by physical measurements.

WAIL, S. S., AND FRENKEL, S. R. Effect of roentgen rays on cell protoplasm. *Virchow's Arch. f. path. Anat. (etc.). Berl.*, 1925, ccIvii, 846–850.

A report is made on cytological experiments designed to show what takes place in irradiated cells during the "latent" period which precedes the stage where demonstrable changes appear in the nucleus. These changes during the latent period may be observed in the cell protoplasm by an examination of the mitochondrial structure contained therein. At least there is the possibility that extended study of the mitochondrial changes will give an understanding of some of the processes occurring in the cell during the early period following irradiation. Such changes are not demonstrable by the usual methods of staining.

The experiments reported were made upon the liver of the frog. This tissue was irradiated from a Coolidge tube, focal distance 23 cm., 180 kv., 4 ma., through 0.5 mm. Cu plus 1 mm. Al, delivering a skin unit dose in 19 minutes. The tissue received from 0.125 to 1.5 unit doses.

The mitochondrial changes in the cell protoplasm were found from four to eight hours after irradiation. The change observed consisted in an alteration of the filamentous and rod-like mitochondrial structures to a more or less granular type. After a while the granules, instead of being uniformly distributed, became clumped and finally assumed a drop-like appearance. At about this time nuclear changes make themselves evident. These observations prove that there are certain morphological changes that can be demonstrated in the cell protoplasm much sooner than in the nucleus. It is, however, pointed out that these first stages of alteration in the protoplasm in the presence of an unchanged nucleus give no index of the injury of the cell. These morphological observations constitute no proof that the roentgen rays exert a stimulative action.

Westman, Axel. Morphological blood changes following radiological treatment of carcinoma of the uterus and breast. *Acta radiol.*, 1925, iv, 220–280.

The author's experience at the Radiumhemmet, Stockholm, is derived partly from cases of cancer of the uterus which received radium treatment, 7000 mg-radium-element hours, divided into three treatments, and partly also from cases operated on for mammary carcinoma and receiving prophylactic roentgen therapy of very nearly one skin erythema dose administered in seven fields, in the course of seven to fourteen days.

Examination of the blood in the cases of uterine cancer has shown that the red cells and hemoglobin are influenced but very little by the therapeutic doses of roentgen and radium rays. The leucocytes were found increased in number directly after the treatments. This increase is due to the neutrophile polynuclear cells. The leucocytosis lasts about one to two days and is followed by a more or less marked leucopenia due to the decrease in number of both the polynuclear cells and the lymphocytes. The monocytes, eosinophiles, and basophiles did not show any very striking variations. Within a month after termination of a series of treatments the blood returns to normal. In those cases of cancer of the uterus that have made unsatisfactory progress after treatment, it was found that during relapse and cachexia there occurred changes in the blood similar to those produced by roentgen rays.

In the cases of mammary cancer the effect of roentgen-ray treatment is to produce a short initial leucocytosis followed by a leucopenia of considerable intensity. This leucopenia involves both the neutrophile cells and the lymphocytes. In those cases making a satisfactory response to the therapy the blood resumes its normal cytological course in about three to five months, while in the unsatisfactory cases there is no return to the normal.

In the author's opinion, the primary leucocytosis after radiation therapy depends on several causes. One of these is the action of the toxins produced by the tumors after treatment and another is the change of blood distribution in the organism due to certain vascular reflexes. The leucopenia is due to diseased blood-producing organs; and the lymphatic system is peculiarly vulnerable. The study of changes in this system may be of prognostic value since a lymphopenia which appears and remains after cessation of the radiotherapy may be considered as a very grave sign.

Wood, Francis Carter, and Prigosen, Rosa E. No immunity produced by inoculating irradiated tumor tissue. *J. Cancer Research*. September, 1925, ix, 287–297.

It has been known that a refractory state against the implanation of certain types of animal tumors can be artificially induced by the introduction of live tumor material, provided that growth and ultimate regression of the engrafted neoplasm takes place. The animal is then found to be resistant to further tumor inoculation.

A study was made of the effects on the inoculability of tumors in the white mouse and rat sensitization by the subcutaneous injection of irradiated tumor. A possible action of such sensitization on already established tumors was also sought.

From the results one cannot conclude that the initial injection of roentgen irradiated tumor materially affects the state of resistance to, or susceptibility to, subsequent inoculations with the Flexner-Jobling carcinoma, sarcoma No. 10, carcinoma No. 11, or sarcoma No. 180. Each tumor group occasionally revealed a slight reduction in the percentage of takes, probably due to certain uncontrolled variations, but these fluctuations are no greater than those observed in control animals.

The data culled from some 6000 experimentations and more than 30,000 control stock inoculations furnish evidence against the assumption either that immunity to inoculation or resistance to a growing mouse or rat tumor can be induced by the inoculation of irradiated tumor material. If no such immunity can be produced in animals, the experimentation on human beings should be

abandoned as useless, dangerous and scientifically unjustifiable.

ZIEGLER, JOSEPH, and HIRSCH, WALTER. The gas content of the gastrointestinal canal and means for its elimination for purposes of roentgen examination. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 698–780.

The composition of the intestinal gases is part-dependent upon the nature of the food and is modified by exchange with the gases of the blood. In the small intestine there occurs a production of carbon dioxide, hydrogen and methane. In the large intestine, as a result of protein putrefaction, there are produced hydrogen and methane and small quantities of hydrogen sulphide, mercaptan and ammonia. The nitrogen in the intestinal gases originates largely from swallowed air. According to some authors, the gases contained in the intestines are free from nitrogen. The quality and quantity of the gases varies considerably even in the healthy individual. Methane appears to be absent in carnivora and where milk is the sole diet; and as is well known, considerable amounts of intestinal gas arise from certain vegetable foods, fresh bread, and carbonated beverages. There are also numerous individual factors that determine gas production.

The quantity of intestinal gases produced in man is about one liter per day. Meteorism occurs when abnormal decomposition and gas production occur in conjunction with decrease in muscle tone and absorption. It is low in dyspepsias, enteritis and typhoid fever, and rather pronounced in peritonitis and ileus. Hysteric meteorism is due to temporary muscular atony and excessive swallowing of air.

Tympany is frequently due to constipation but good evacuations do not necessarily eliminate this difficulty, although they are a prerequisite. Milk diet and calomel have been recommended as a good method for eliminating putrefactive products. A still better procedure is administration of kefir for three days, the kefir being freed from carbonic acid by warming and shaking. Good results have also been obtained with a diet of fine wheat crackers, richly buttered spinach, carrots, kohlrabi, creamed soups of wheat, maize and rice flour, cocoa, chocolate, red wine and grog. Massage has often been found useful. Some have recommended cupping as very effective, especially in old people with chronic ileus. In cases of acute partial colonic dilatation and of paralytic ileus good results are secured with warmth, light applications, hot baths, and enemas. The tympany in cardiac cases is frequently corrected by breathing exercises.

The above procedures are also combined with various medicinals such as spirits of camphor, atropine, physostigmin, hypophysin, cholin, novocain by lumbar puncture, and various purgatives.

Direct roentgenoscopic observations have shown that massage may shift the position of the intestines but it has never been possible to massage out the gases into other portions of the gut. In general, it may be stated that the main portion of the gases is not, as usually stated, in the region of the flexure but is found mostly in its vicinity in the ascending, transverse and descending colon. These systematic examinations of unprepared individuals taken at various times show that the quantity of gas in the intestinal canal varies spontaneously within wide limits, although the distribution of the gases is practically always the same.

A comparison of the effectiveness of the various purgatives showed calomel to be the best and castor oil next. In general, avoidance of the morning meal is a useful practice. Prolonged fastings or very stringent dieting is of relatively slight value and should not be imposed on patients who are already in a weakened condition. An enema of lukewarm water is very effective, provided examinations are made shortly thereafter. This procedure is more effective when soap water is used. In obstinate cases the quantity of the enema may be increased up to two liters and may be repeated, the roentgenoscopic examination being made as soon after the enema as possible.

Medication with carbon black (animal charcoal) does not appear to have any great influence on gas in the stomach but a considerable reduction has been observed in the intestinal gases for a limited period. Enemas containing charcoal are of some effect but should not be combined with soapy water since the surface activity of the carbon upon which gas absorption depends is very much reduced by the surface-active soap. Roentgenoscopic examinations should be made promptly because new gas formation was observed two hours after the infusion with carbon.

Where the above procedures are ineffective infusion of liquid paraffin, which is again promptly withdrawn, seems to be effective, but care should be taken not to introduce air in the process of applying the enema.

Another procedure depends upon roentgenoscopic technique, namely, the placing of the tube so that the roentgen beam passes above or below a gas distended viscus. This procedure is assisted by abdominal compression and use of the Bucky diaphragm. In pyelography such a procedure is the method of choice

ZUELZER, MARGARETE, and PHILIPP, ERNST. Affecting the colloidal state of the cell content of protozoa by roentgen rays. *Biol. Zentralbl.*, 1925, xlv, 557–572.

Experiments were made with radium preparations inclosed in glass and platinum when placed in close proximity or directly within the suspension of parasites studied. The experimental material consisted of amebae, flagellates and spirochetes. Microscopic observations were made on the appearances of these organisms from time to time during the irradiation.

The experiments on the amebae showed, before the occurrence of injury, the development of a stage in which the rays produced an acceleration in protoplasmic streaming. This acceleration in streaming is due to a liquefaction of the protoplasm, and is also made evident by an acceleration in movement of the organism. These results show that the irradiation causes a change in the stage of turgescence through hydration of the protoplasmic colloids. This is the primary effect, and only secondarily do we find differences between nucleus and plasma. The latter differences undoubtedly exist but cannot be specified at present.

Corresponding to the make-up of their cytoplasm the spirochetes appear to be extraordinarily resistant to roentgen rays. *Spirochaeta obermeieri* contains relatively fluid protoplasm and is killed by large doses of radium, while in the case of *Spirochaeta icterogenes*, even much higher doses fail to cause the slightest morphological changes, because the protoplasm in the latter organism is of a very firm gelatinous consistency. The protoplasm which is fluid is more labile and more susceptible to the effects of the rays than is the more solid protoplasm.

The first reaction following irradiation is an acceleration in protoplasmic streaming which produces acceleration in movement. This reaction may be interpreted as an acceleration in function. This, however, could hardly be considered a stimulation of the organism, for the effect is merely one step in the direction of dissolution. If this is considered a stimulation, then any alteration in state becomes a stimulation, and the term does not advance us in the knowledge of the actual mechanism. No acceleration in growth was observed in the organisms subjected to irradiation. These experiments are far removed from offering any explanation as to the late reaction and the general effects produced by irradiation in man, but they do indicate, in a certain sense, what the direct effect of radium rays upon the living cell depends upon.

ZUELZER, MARGARETE, and PHILIPP, ERNST. The effect of radium radiation on the colloidal state of the cells contents of protozoa. *Strahlentherapie*, 1925, xx, 737–770.

Is there a stimulative action of the rays in the sense of an increase of growth or of function, or how are we to interpret the phenomena that have been regarded by other authors as a stimulative action?

The experiments of the authors show that the primary response to irradiation is an acceleration of protoplasmic streaming resulting in an accelerated movement of amebas. This response may be termed "acceleration of function," and consequently a stimulative effect. Further study of this response shows that it depends upon an alteration in the colloidal condition of the cell by the radium rays. In reality the irradiated animals have not been stimulated to an increased function in the strictest sense of the term, and the apparent increased activity is due entirely to a physico-chemical change. To term the mere change of existing state as a stimulative action does not further our understanding of the problem; and in this sense any action which results in an altered condition would be considered a stimulation.

From the studies of Chambers, Heilbrunn, Belar, and others, we know that a phase change in the protoplasm may follow as a result of a variety of conditions. Under normal conditions this occurs immediately preceding every cell division. Before a cell divides, there occurs a change in the consistency of its protoplasm and nucleus and they become more fluid because of certain internal, as yet unknown, conditions. This is the mechanical prerequisite for cell division. It is consequently not difficult to imagine that as a result of accelerated fluidification caused by radium rays, i.e., through the production of the condition prerequisite to cell division, this process is enabled to proceed more rapidly than normally. This may explain many observations tending to show an increased growth as a result of radium radiation.

Such an acceleration in growth has not been observed in the experiments with protozoa, but this may perhaps be due to the nature of the material. Metazoa and protozoa and especially plant and animal organisms may under circumstances respond differently. The factor that must be common to all of them, however, is the response of their protoplasm which fundamentally must have a uniform physico-chemical make-up; and the colloidal condition of this protoplasm is affected in the same way in each case by the radium rays. It is to be expected that there will be quantitative differences, and this is well exemplified in the experiments with

amebae where the viscous cell contents become highly fluid as a result of exposure to radium. This phenomenon precedes the appearance of injury.

It may be stated *a priori* that very fluid cells will be more rapidly injured by radium radiations than the viscous type which first have to undergo a change in phase. With continued exposure there occurs an irreversible alteration in state of the cell content known as "injury." The kind and intensity of the radiation do not alone determine the end effect, they are very largely dependent upon the colloidal condition of the object.

These observations may bring us somewhat nearer to an understanding of the very important question of the variation in radiosensitivity of various tissue and cells. It may explain the high sensitiveness, for instance, of testicular and ovarian tissue with their numerous actively dividing cells; and the high sensitivity of ascaris eggs preceding the two-cell stage; and the ease of action upon rapidly growing clinically malignant carcinomas. The effect of radiation is not a selective action upon the mitoses but rather, depends on the fact the cell substance of dividing cell is in a sol-state and possesses an increased dispersion as compared with the resting cell of the same tissue. These cells with increased dispersion are the more radiosensitive. No distinction has as yet been made between the nucleus and protoplasm in regard to the phenomenon of liquefaction. Undoubtedly such a distinction exists but only as a secondary factor.

ZWEIFEL, ERWIN. The distant action of roentgen rays. *Strahlentherapie*, 1925, xx, 565–573.

A report is given of a case occurring in a woman suffering from fibroexudative pulmonary tuberculosis, Basedow's disease and amenorrhea. She received the following roentgen treatment: 30 per cent of the skin unit dose over the spleen, and 15 per cent over the left thigh; 8 days later she received 15 per cent over the left arm and left forearm; 7 days following she received 15 per cent over the right upper arm and forearm. The treatment was discontinued and examination of the patient two months later showed considerable improvement in the thyroid and in the pulmonary conditions. The patient was re-examined several months later and her condition was still more improved.

The first noticeable distant effect of the irradiation was the betterment in the tuberculosis. The temperature was improved and there was a gain in weight. A further effect was the recession in all the symptoms of Basedow's disease. It is emphasized that all these effects are indirect ones since the radiations were administered with an apparatus in which scattered radiation was eliminated by lead.

Another striking distant effect of the irradiation was the return of the menstrual period, which had been absent for the year preceding. In addition, the patient exhibited a marked exhaustion after each irradiation. Since the doses administered were small, it would seem that this patient was somewhat hypersensitive to the radiation, perhaps as a consequence of the thyroid condition. This fatigue occurred within a few hours after treatment and lasted until the next day, but the intensity diminished with each succeeding treatment.

BORAK, J. Roentgen therapy and organotherapy in endocrine diseases. III. Reciprocal relations of endocrine glands during the climacterium. *Strahlentherapie*, 1925, xxi, 31–55.

An analysis of the various known facts indicates that in all diseases due to hyperfunction of the extragenital main glands in so far as hyperfunction in these is definitely known (which is not the case with the adrenals), there appear certain phenomena which are very similar to the climacteric symptoms. Further, these symptoms are in particular also identical with those phenomena which can be observed after the administration of organ preparations from these glands (adrenalin, thyroidin, pituitrin). Anatomical findings, clinical observations, experimental results and therapeutic effects all lead to the same inference that the climacteric symptoms are directly due to hyperactivity of the consecutively hypertrophying extragenital main glands, and not to cessation of function of the ovaries. In other words, the varying activity of the complementary hormonal glands is responsible for the clinical effects observed.

From the fact that after cessation of ovarian activity, the remaining extragenital main glands hypertrophy, one might conclude that it would be necessary to irradiate *all* those glands, the hyperactivity of which is responsible for the increased function of the vasomotor system, in order that a depression of function of the glands may permit a calming of the nervous system. In fact, this is not always practicable. Just as in the treatment of Basedow's disease, it is not absolutely necessary to have a total extirpation of the thyroid, since a mere resection suffices, so also is an irradiation of a portion of the gland system sufficient for therapeutic control of the climacteric symptoms.

There are also cases in which the irradiation of one gland is without effect, and a successful effect is obtained from the irradiation of some other gland. This peculiarity is believed by the author to lie in the fact that there are different constitutional types amongst individuals who are characterized by peculiarities such as those in the various hormonal glands. For instance, it is found that climacteric women of the obese type react better or even exclusively to irradiations of the hypophysis, while those of the lean type react somewhat more favorably or exclusively to irradiations of the thyroid. The body weight is not the only deciding criterion, the general appearance and the symptoms are all characteristic. In other words, the effect of the irradiation in such cases becomes a functional test.

In some 150 cases in which roentgen rays were applied by the author to the hypophysis or thyroid, the treatment is reported as having been successful in 92 per cent. In about half of the cases the result was especially satisfactory because other treatments had been without effect. Complete disappearance of the symptoms is of course more unusual than amelioration to a tolerable stage. The effect in those cases that responded promptly usually lasted the longest. In over 40 per cent of the cases, a series consisting of two to four irradiations gave relief from symptoms for at least half a year. There were of course cases that had to return for further treatment, and it was found that these recidives reacted in the same manner as they did after the first irradiation. The headaches seemed to be permanently relieved. Consequently, the author has attempted the treatment of habitual headaches with roentgen rays, and the results appear to be very satisfactory. In addition the interesting observation has been made that certain of the accidental or secondary climacteric symptoms also undergo improvement after roentgen irradiation of the hypophysis or thyroid. For instance, pruritus vulvae, arthralgia, and also glycosuria and constipation seem to be relieved.

The irradiation technique consists in the application of 4 H, i.e., one-third of the skin erythema dose, as a surface dose, with zinc filter for irradiations of the hypophysis and an aluminum filter for thyroid irradiations. The dose at the gland is, on the average, 10 per cent of the erythema dose for each portal. The hypophysis can be irradiated through each of the temples and frontal protuberances with portals of 4 to 9 sq. cm. The thyroid may be irradiated either through one single large field in front or two small ones, with the patient lying on the side and the roentgen beam frontal. Between two treatments there should be a pause of at least four days, or otherwise there will be an increase in the symptoms, especially the headache. After two irradiations there should be a pause of eight days, and then a repetition or else an irradiation of the other gland. Speaking in general, it may be said that the method will often give quicker, better and more permanent results than those secured with the customary symptomatic materials now employed for these symptoms.

ZWEIFEL, ERWIN H. The prevention of sickness after x-ray treatment. *Brit. J. Radiol.*, July, 1925, xxx, 267–268.

The author has obtained good results in the prevention of roentgen sickness from the use of 200 c.c. of salt solution given either as an enema or in subcutaneous injection (strength not stated). Another preventive of roentgen sickness is the enclosure of the tubes in lead boxes so constructed that only the required dose escapes.

CHANTRAINE, HEINRICH. The reliability of timing in exposure timers. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 981–982.

A study was made of two Heliopans and one Siemens and Halske universal roentgen apparatus, the former having timers indicating hundredths of a second, the latter tenths of a second. The timer on the Heliopans was found to give results reproducible to within $\frac{1}{100}$ of a second. The zero position of the timer pointer lies between two black marks on the scale because 0.02 to 0.01 sec. is required for the switch to break the current. The scale divisions, however, do not indicate the exact time of exposure but a multiple (twice or more), and the scale should therefore be calibrated.

The scale of the exposure timer of the Siemens machine was found to correspond to actual exposure intervals but the accuracy of the device was only one-quarter that of the Heliopans owing to the coarser scale divisions.

CRAMER, H. On the biological action of radiations. *Klin. Wchnschr.*, Jan. 29, 1926, v, 190–192.

The following effects of roentgen and radium radiations upon the living organism may be distinguished: (1) a photochemical reaction; (2) a local tissue reaction; (3) an immediate general reaction; (4) a temporary functional acceleration; (5) a dependence of the reaction upon an intact circulation. The reaction is non-specific in character and is apparently concerned with a catalytic oxidation involving iron. This reaction in the case of the frog is inhibited during

winter hibernation; which may be explained as due to lack of oxygen during that period.

The above summary is based on studies made upon the frog's mesentery using a 1 per cent trypan blue solution in Ringer's fluid as an indicator of the tissue reaction.

Courses in Radiology. *Radiology*, February, 1926, vi, 91–112.

A compilation is presented of the courses of instruction in radiology offered by the various collegiate institutions in the United States. This compilation is not claimed to be exhaustive, 37 institutions being represented. The facilities for radiological instruction of some are presented in detail, while in others only a brief statement is made.

DARLING, BYRON C. Financing the clinico-pathological and x-ray laboratory in the hospital and also conserving the professional and economic interests of its medical personnel. *Radiology*, February, 1926, vi, 127–130.

What applies to clinico-pathological laboratories also applies to the roentgen-ray laboratory in regard to the economic status of the physician who specializes in laboratory work. In hospitals the general proposition should be that all paying patients should pay a graduated fee to the laboratory. In the case of clinico-pathological work the best procedure is to make a flat laboratory fee of so much per month per patient for what might be described as routine urine and blood work. This lump sum fee obviates the many book-keeping items of separate charges.

In the roentgen-ray department the examinations occur less frequently; the public is trained to appreciate the cost and the separate fees can be collected along with the regular hospital bills, free patients free, and paying patients according to their ability to pay. The fees in all cases should be reasonable and based on the scale maintained in neighboring private laboratories of physicians of recognized ability.

The head of the laboratory should have such complete control of his department that it will make no great difference to him whether he does part of his private work or all of it in the hospital. The hospital should not be permitted in any way to control or intercept any part of his earning capacity any more than it does that of any other visiting physician or surgeon. A strict accounting should be maintained as regards the use of equipment so that the benefits obtained by the roentgenologist may be equitably offset by those obtained by the hospital.

Where the hospital manages the laboratory it has only the hospital point of view; since hospitals are primarily charitable institutions they are always short of money and always behind in funds to make the necessary improvements to keep abreast of the times. Consequently the laboratory is seen as either a financial drag or an opportunity for financial gain. The laboratory and its medical officer in the hospital should be economically independent of the hospital itself.

Among other things, physicans need to be protected from each other. No technician who ever started an independent laboratory did so without definite encouragement from some well-established physician or group of physicians or hospital trying to obtain something cheaper than a professional level. In time the skilled expert knowledge of the physician in charge of the clinico-pathological laboratory and the roentgen laboratory will receive recognition and recompense, but not until he has fought for his rights.

DEBICKI, JOSEPH. X rays and the problem of races. *Brit. J. Radiol.*, 1925, xxx, 486–489.

In the cultivation of plants and in the breeding of animals, only such specimens are selected which possess prominent qualities that answer the purposes of the breeder. In this way the species is being constantly improved by the elimination of unhealthy or otherwise imperfect specimens. Mankind should also strive to produce a race of men perfect both physically and intellectually. The author urges that it is uot impossible to obtain a solution of the hnman problem by means of roentgen rays. Since the community has the right to deprive one of his liberty or even of his life, when this is imperative from the point of view of common welfare, it has also the right to prevent lunatics, criminals and such like from reproducing their species and from causing thereby immeasurable damage to the community at large. Through the liberalization of our ideas on what constitutes punishable crime there may be reasonable doubts as to the justifiability of certain corrective procedures instituted under the guise of "punishment." It is obvious, however, that a rationally organized community must be defended against the prolific and unhindered reproduction among imbeciles, epileptics and criminals; and here there is adequate justification for a compulsory sterilization of all individuals whose pathological tendencies may be transmitted to their offspring. This applies primarily to habitual drunkards, incurable lunatics, epileptics, imbeciles, drug takers, and finally those suffering from advanced consumption or syphilis.

In the selective action of roentgen rays upon the germinative cells of the sex glands we have

a means for complete sterilization without any harmful effects on the internal secretory activity of the glands. The health of the individual thus sterilized will not be impaired in any way; and he will retain his secondary sex characteristics and unimpaired function of his external sex organs.

A male individual can be sterilized in a very short time by the systematic application of small doses. In the sterilization of women we must accept the consequences of the cessation of ovarian function. It is possible, however, to prevent this by means of irradiations of the hypophysis according to the method of Borak.

ERSKINE, ARTHUR W. Efficient and economical filtration. *Brit. J. Radiol.*, 1925, xxx, 479–482.

It is proper to assume that the most nearly ideal filter will be the one which permits the delivery of the highest percentage of surface radiation to a depth when compared with other filters which equally increase the time required for a surface dose. To obtain the data for this study readings were made of the time required to discharge an electroscope with the ionization chamber at the surface of a water phantom and at a depth of 10 cm., using unfiltered rays first and then gradually increasing thicknesses of the various filter materials investigated. From the data, the gain in penetration with increasing filter thickness, expressed as depth percentage, was plotted against the loss in surface intensity, expressed by the increasing time required to produce a given ionizing effect. The relative efficiency of the various materials is easily shown by comparing the depth percentage corrections at points where equal percentages of the original beams have been absorbed, as indicated by the increase of the surface dose time in equal multiples.

Since copper compares rather favorably with other materials such as zinc, brass, iron, aluminum, glass and tin, especially at the higher voltages, because it is easy to obtain pure copper in sheets of uniform thickness and because of its present almost universal use, it seems advisable that the continued employment of copper filters be urged. The limit of economic increase in filter thickness varies with the voltage. The actual thickness of copper absorbing various percentages of the unfiltered beam of roentgen rays was determined for voltages between 140 and 160 kv., and the data are presented in a chart.

FRIED, C. Bactericidal action after roentgen irradiation. *Strahlentherapie*, 1259, xxi, 56–72.

Heidenhain and Fried have reported on the favorable results obtained in the roentgen irradiation of acute and subacute inflammations and suppurations. On an average, 70 per cent of the cases have been healed or very much improved by this treatment; and in postoperative pneumonias and gynecological infections over 80 per cent of the irradiated cases have been improved. The roentgen doses employed for superficial conditions vary from 48 to 120 R which correspond to 6 to 15 per cent of the skin dose. For conditions in the deep portions of the body, very small quantities of roentgen rays (32 R) have been found effective. In the majority of these cases, the course of the disease following irradiation pointed quite definitely to the operation of immunological phenomena.

The author has sought experimental confirmation of the clinical conclusion as to the existence of an immunizing process. Dresel and Freund had already shown that the blood of irradiated rabbits possessed strong bactericidal power. It seemed to the author that it might be possible to demonstrate the production of an antibacterial state in the human being by irradiation.

Experiments were made upon the venous blood of 68 patients. Of these, 21 had to be excluded because their bloods showed high bactericidal power before irradiation. Most of the 21 were in a febrile condition at the time the blood was removed. In the remaining 47 cases, some 200 separate experiments were made, and it was found that over 62 per cent showed a distinctly increased bactericidal power of their blood after roentgen irradiation. The cultures used in testing for increased bactericidal power were *B. anthracis*, *Staphylococcus aureus*, *B. typhosus* and *B. coli*.

It is concluded that the increased bactericidal power is due to the irradiation, because this increase does not appear until two days after irradiation of a patient in the nonfebrile stage. Experiments with serum irradiations demonstrate that the bactericidal power is conferred only in the living body in the circulating blood, *in vitro* experiments proving negative. In 3 cases an attempt was made to determine whether the elaboration of bactericidal power depended in some manner upon the magnitude of the dose of roentgen rays. The results showed clearly that doses of 400 R (primary radiation), i.e., doses representing 2.5 to 4 times that employed in the treatment of inflammations, do not destroy whatever bactericidal power is present, but neither do they generate a bactericidal power nor increase the amount present.

Attempts were made to discover if any bactericidal action could be generated in pus. The demonstration of this is exceedingly

more difficult than in blood serum. The experiments do not permit the author to affirm that roentgen rays are capable of increasing the bactericidal power of pus. In only 2 cases, in which the pus could be examined very soon after irradiation, could there be demonstrated any increased bactericidal action. In the examined serous fluids with one exception there never was found any bactericidal power either before or after irradiation. The exception was an ascites of an unirradiated tuberculous guinea pig, this fluid being strongly bactericidal against *B. anthracis*, but entirely inactive against staphylococci.

GASSUL, R. The effect of radiations upon living cells *in vitro* (explanation experiments). *Klin. Wchnschr.*, March 26, 1926, v, 560–561.

Tissue cultures were made of the spleen cells and the ciliary epithelium of *Rana temporaria*. As a control, the effect of daylight was studied by growing one set of cultures in the dark and another in open daylight. It was found that exclusion of daylight favored one-third or one-fourth greater duration of life of the cultures. The lymphocytes in the illuminated cultures died off more rapidly, and ciliary activity stopped sooner although it exhibited greater activity in the beginning.

A roentgen dose of 5 to 40 per cent of the skin unit dose filtered through 0.3 mm. Zn plus 3 mm. Al at a distance of 30 cm. (Neo-Intensivreform-apparatus, Coolidge tube, 190 kv., 4 ma.) applied to the tissue cultures produced no noticeable effect. Higher doses, from 40 per cent up to 300 per cent of the skin unit dose, caused an immediate acceleration in ciliary activity continuing for six hours and gradually decreasing or entirely stopping in one to two days. This effect was very pronounced in *young* fresh explants; *old* explants already possessing a weakened ciliary rhythm responded by a deceleration or stoppage of motion within twelve hours after irradiation with *unfiltered* roentgen rays. The accelerated motility corresponded to an increased reducing power of the ciliary epithelium upon methylene blue, and a decreased activity with decreased reducing power.

Cytological studies were also made upon the treated and untreated tissue cultures. Young explants showed no morphological changes with doses below 60 per cent of the skin unit dose. Higher doses produced visible changes in the protoplasm and nucleus, mostly of a destructive nature. These effects were most pronounced in the protoplasm after unfiltered irradiation. In the case of filtered irradiations the most pronounced changes were found in the cell nuclei. These were especially noticeable in the erythrocytes of the frog's blood. It was also observed that *non-irradiated*, older cultures exhibited the same changes found in the irradiated tissue cultures.

HERMAN, KARL. Cholecystography by the oral method. *Deutsche med. Wchnschr.*, June 11, 1926, lii, 997–998.

Apart from the avoidance of disagreeable reactions, the oral method of administration of the dye for cholecystography has the further advantage over the intravenous method in that the physician is saved the two hours required for preparing and making the injection. It is claimed that disagreeable reactions were more the rule than the exception after intravenous injection.

The author employs Merck's gelatin capsules containing the tetrabrom salt in quantities of 0.5, 0.3 or 0.25 gm., the smaller capsules being given in cases where patients have sensitive throats or where pylorospasm is present. The suggestion of American authors to follow the capsules with a dose of alkali in order to relieve pylorospasm caused by acidity is valuable; but one should remember that certain forms of spasm are not due to gastric hyperacidity. The author confirms the observation of Graham that there are practically 25 per cent failures of visualization in cases receiving the dye by the oral method; but it is claimed that the 75 per cent success can be increased to 95 per cent. There will remain a certain number of cases that cannot be visualized by this procedure. Among them will be found pyloric stenosis, duodenal stenosis, certain cases of intestinal amyloidosis, stasis in the region of the portal artery, cirrhoses, tumors, syphilis of the liver, stenosis of the gall-bladder and biliary passages, occasional cases of linitis plastica, catarrh of the small intestine, acute motor unrest, etc. In these particular cases a Rieder meal should be given in order to gain a clear idea of the nature of the passage through the pylorus.

The normal gall-bladder is visible after twelve hours, and the diseased gall-bladder later or not at all. The degree of filling is variable, diseased gall-bladders showing the lighter shadows, but this point should be interpreted with caution, since the judgment is subjective. It is pointed out that the diagnosis of a pathologic gall-bladder is based essentially upon the *absence* of a shadow after the administration of the dye. This means that a positive diagnosis is based upon a negative finding, which is not at all conclusive; unless care is taken in checking up all sources of error and the clinical findings are strongly indicative. The fact that American authors report 90 to 95 per cent correct diagnoses as confirmed by operation speaks well for

the methods of control employed in eliminating all possible errors.

A case occurring in a woman aged fifty-five is reported. There was positive demonstration of gallstones, and in addition the gall-bladder failed to fill with the orally administered dye.

HOLFELDER, HANS. Side effects in roentgen therapy. *Deutsche med. Wchnschr.*, June 11, 1926, lii, 1005–1007.

Mention is made of the fact that there is no adequate provision in German law regarding compensation for roentgen-ray burns received during treatment; and it is claimed to be scientifically proven that ulcer formation accompanied by tissue breakdown following a treatment with roentgen rays is due nowadays to avoidable excessive dosage. It is practically unanimously agreed amongst experts that ulcer formation cannot be explained as due to an idiosyncrasy toward roentgen rays. There is indeed a certain idiosyncrasy which occurs only very rarely (perhaps in one case out of 100,000), and furthermore this condition is accompanied by a unique disease picture. Not only can gross injuries, such as ulcers, be avoided by proper precautions, but the other undesirable side effects may be excluded with practical certainty, and in the few cases where these effects cannot be entirely eliminated they may at least be reduced to a tolerable stage.

Since roentgen rays *per se* are not a specific therapeutic agent, it follows that a therapeutic result can be attained only by individualized treatment. One point to be remembered is that the zone undergoing irradiation shall be the minimum possible in order that general toxic effects may be minimized. The history of roentgen sickness shows the progress that has been made in decreasing the disagreeable side effects incident to roentgen therapy. The proper construction of roentgen apparatus has done a good deal in this direction. A considerable rôle is played by certain disturbances of metabolism and certain injuries to the vegetative nervous system and the chromaffin system, and in cases of prolonged and stubborn effects upon the general well being, there is apparently a profound change in the blood picture that is responsible. These blood changes have been followed, and it has been shown by Jüngling that the degree of blood injury runs almost parallel with the magnitude of the space dose administered.

The alteration in metabolism following the action of roentgen rays has not yet been satisfactorily explained. It is known that sodium chloride administered in hypotonic or isotonic solutions relieves the symptoms, but the same effect can be produced by the injections of hypertonic solutions of glucose; and Nevermann reports the same corrective effect by the administration of 20 c.c. of cognac immediately after the irradiation. The increases in temperature following irradiation either with roentgen rays or with radium seems partly due to resorption of toxins, and mechanical stasis of secretions and the like.

In previous years account had to be taken of the fibrosis produced in the lung following chest irradiation, but nowadays this difficulty can be avoided by flanking irradiations of the chest wall. It may be stated, in summarizing, that the more serious side effects of radiation therapy can nowadays be avoided with great certainty. The important requisite is that roentgen rays shall be administered only by an individual who has undergone a successful special study and has had, in addition, an adequate experience in which his skill at this special type of work has been demonstrated.

HICKEY, P. M. The teaching of roentgenology in the University of Michigan. *Radiology*, February, 1926, vi, 125–126.

It is felt that the enthusiasm of the student would be better stimulated if there were a more intimate connection between the preclinical and the clinical subjects. One of the newer ways of promoting this liaison is by the introduction of roentgenology in the freshman and sophomore years. The use of the roentgen ray as an aid in teaching anatomy is serving to link the subject of anatomy with medicine and surgery. Accordingly in the University of Michigan through the cooperation of Dr. Carl Huber, professor of anatomy, the department of roentgenology gives a certain number of lectures and demonstrations in anatomy to the freshman students. These lectures are intended primarily not to introduce the subject of roentgenology but rather to make use of the roentgenogram as an adjuvant in the study of anatomy. The lectures illustrate the development of the skeleton during fetal life and during the growth of the child. These lectures are not confined alone to the osseous structures but take up the circulatory, respiratory and digestive system.

Didactic lectures on roentgenology are now given in the junior year so that the student will on entering his senior year have acquired an elementary knowledge of roentgenology and of film interpretation. Demonstrations are given of the simpler types of roentgen apparatus, and lantern slides are shown illustrating the uses of roentgenology in the various phases of medicine.

Special elective courses are also offered to seniors and comprise demonstrations in film

reading and elementary roentgen technique. A considerable percentage of senior students elect these optional courses, more especially the one in film interpretation. An elective course in roentgen therapy is given, which is not intended to qualify the student to do roentgen therapy but rather to acquaint him with the broad clinical facts of this form of therapy.

Each senior student is expected to be present at the roentgenoscopic examination of gastric and pulmonary cases which have been assigned to him. As much care is taken in stressing the limitations of roentgen diagnosis as in the demonstration of the positive findings of roentgen-ray study.

The department of physics gives a pre-medical course in physics which teaches the fundamentals of roentgen-ray physics. This course includes both lectures and practical laboratory work, and resident interns in roentgenology take this course as part of their hospital training.

HUSSEY, R. G., and THOMPSON, W. R. The effect of radioactive radiations and *x*-rays on enzymes. V. The influence of variation of the thickness of the absorbing layer of solutions of pepsin upon the rate of radiochemical inactivation of the enzyme. *J. Gen. Physiol.*, Jan. 20, 1926, ix, 309–313.

Evidence is presented which indicates: (1) that the effect of gamma radiation is negligible with respect to that of beta radiation upon pepsin in dilute solution under the experimental conditions; (2) approximately the thickness of fluid layer which may be regarded as necessary and sufficient to practically absorb the available beta radiation; (3) that the mean reaction speed coefficient in radiochemical inactivation of pepsin varies inversely with the volume of solution irradiated if the thickness of the fluid layer is sufficient to completely absorb the beta rays, and beyond this as far as has been studied.

HUSSEY, R. G., and THOMPSON, W. R. The effect of radioactive radiations and *x*-rays on enzymes. VI. The influence of variation of temperature upon the rate of radiochemical inactivation of solutions of pepsin by beta radiation. *J. Gen. Physiol.*, Jan. 20, 1926, ix, 315–317.

The radiochemical inactivation of the enzymes: trypsin, pepsin and invertase, has been found to proceed as a monomolecular radiochemical reaction. Experiments were made to determine what effect variation in temperature has upon the reaction velocity in the case of pepsin. The data show that variation in temperature (between 0 and 20°C.) is associated with only slight variation in the velocity of inactivation.

JERMAN, E. C. Calibration as an aid in the standardization of technical procedure. *Radiology*, February, 1926, vi, 151–152.

The predominant factor responsible for the failure to duplicate results in roentgenography has been the voltage or gap factor. The other elements may be duplicated with little difficulty, but because of quite ordinary line fluctuations and of the inaccurate point gap method of measuring the voltage, it has been found exceedingly difficult to duplicate this factor. A 5-inch gap as measured and used by one individual may have an entirely different value when measured and used by the same individual at another time or when measured and used by another individual. The point gap method is affected by so many variables that duplication of the energy to be delivered by this method is impossible; and it should be discarded for diagnostic work as it has already been done in deep therapy.

Any autotransformer-controlled machine, with mechanical rectification, can be calibrated within its capacity. Calibration necessitates the machine being equipped with a pre-reading voltmeter. A pre-reading voltmeter should be a standard voltmeter, connected in the circuit between the autotransformer and the high tension transformer, which reads the voltage delivered from each button of the autotransformer to the primary of the high tension transformer, with the roentgen-ray switch open, or off. A standard sphere gap with the proper altitude K.V.P. scale should be used. The average time required for full calibration is approximately three hours. The value of the calibration depends entirely upon the accuracy with which the measurements are made.

An example is given in the form of a calibration of a Snook machine. The pre-reading voltage (autotransformer voltage) for each button of the autotransformer is given as found at the time of calibration. There is also given the K.V.P. for each autotransformer button at its pre-reading voltage at the time of calibration for each milliamperage ordinarily used in diagnosis.

Following calibration the autotransformer button numbers are used only as a guide. The variation of the line voltage will cause a corresponding variation of the pre-reading (autotransformer) voltage for each button. A definite autotransformer voltage at a given milliamperage will always produce the same K.V.P. Therefore in order to produce a given K.V.P. at a given milliamperage, it is necessary

to use the same pre-reading (autotransformer) voltage that was used at the time of calibration regardless of the autotransformer button numbers.

Johnson, Clayton R. The "radiogrameter." *Radiology*. February, 1926, vi, 131–137.

The author offers a method similar in some respects to the one suggested by Chamberlain and Newell except that all mathematical calculations are eliminated. The new method is applicable not only to the problem of pelvimetry but also to all those conditions in which mensuration between various points shown on the roentgenogram would be an aid to diagnosis.

The scale, or "radiogrameter," has the form of a truncated right angled triangle, engraved preferably on a metal plate. It consists of a series of lines parallel to the base of the right angled triangle, and a series of meridian lines crossing them. The intervals between the lines have been determined mathematically. When roentgenograms are taken according to the method to be described each line on the scale represents the actual height above the base of the scale, of a plane passing through a point having a shift in its shadow when measured in millimeters corresponding to the numbers along the altitude of the scale. The meridian lines radiate from a point on the projected altitude of the scale 635 mm. above the base line of the scale and fall at intervals of 5 mm. along this base line.

The remaining necessary apparatus consists of a lead plumb bob, square in cross section, a 1 mm. Al filter, from the center of which the plumb bob is suspended by means of a cord, an accurate 20 cm. architect's rule, ruled in 0.5 mm., a pair of fine point dividers, and a 10 cm. metal bar. This bar is used as a check on the accuracy of the technique. The length of the bar may be calculated from its shadow on the roentgenograms and if this agrees with the actual length the technique is judged correct.

The technique for making the roentgenograms is: (1) place the 1 mm. Al filter in position beneath the tube and from its center, through a pin hole, suspend the plumb bob by means of the cord; (2) center the tube in the lead glass bowl so that its focal spot is in direct line with the cord supporting the plumb bob; (3) adjust the focal spot film distance to exactly 635 mm. or 25 inches; (4) place the 10 cm. metal bar in some position on the subject to be roentgenographed so that its shadow will be cast upon the film; (5) make stereoscopic roentgenograms using a shift of exactly 63 mm. or 2.5 inches, being very careful to have the films in the same position for each of the two exposures.

The center of the plumb bob shadow represents the point of reference from which the distances of other points on the roentgenograms are measured with the dividers. Then by use of the radiogrameter and the architect's rule and taking into account the shift of any particular shadow in each of the two stereoscopic films the true distances are read off.

In practical application of the method the different conditions in pelvimetry were surmounted very satisfactorily. In order to get well oriented as to anatomical points shown on the roentgenogram from which various measurements were to be made, a dry pelvis was placed in the position on the table similar to that of the pelvis of an imaginary patient. Stereoscopic roentgenograms were made according to the technique outlined. The various diameters of the pelvis were calculated and compared with the diameters as measured directly on the pelvis by another observer. In no instance was there a variation of more than 1 mm. between the calculated and the actual diameters. The method was put into actual practice with satisfactory results. Four illustrative cases are cited.

Jona, M. On pulsating or constant high voltage direct current in the practice of roentgen therapy. *Klin. Wchnschr.*, March 19, 1926, v, 509.

This is a comment on a paper by Rahm under the same title. The increase in radiation output by the introduction of condensers, as claimed by Rahm, is actually lost because of the resulting drop in potential. Roentgen apparatus fitted with condensers should be accompanied by charts showing the necessary milliamperage to produce the required secondary voltage at any given primary voltage. Only spectrographically determined voltages are of any reliability, and such calibration is especially necessary in those cases where a transformer apparatus is converted to constant direct current operation in combination with condensers.

The suggestion of Rahm to use variable condensers to be adjusted when installed involves great technical difficulties. Besides the capacity of the condensers can be determined theoretically for the definite increase in output expected. However, it may be reiterated that the employment of correct principles of construction and reliable calibration make it possible to realize the theoretically expected improvement in output by the use of condensers in going over from pulsating high potential to constant high potential.

JUDA, ADOLF. A simple method for the roentgenological estimation of the size of the heart. *Deutsche med. Wchnschr.*, June 4, 1926, lii, 956–957.

The transverse diameter of the heart shadow in the orthodiagram is compared with the transverse projection of the individual's vertically held right fist. Where the orthodiagraphic apparatus is not available, the author suggests a procedure whereby the projection of the shadow of the fist can be made under exactly the same geometric conditions as the heart roentgenogram. The heart roentgenogram should be taken with an exposure of 2 to 3 sec. so that a maximum expansion of the organ can be registered.

Numerous measurements show that the transverse diameter of the right fist has a constant ratio to the transverse diameter of the heart (within variations of 1 to 2 mm.) the proportion being 1 to 1.1.

The author notes that this utilization of the relationship between the size of the heart and the right fist is not new, since Levy-Dorn made the same suggestion in 1910. Apparently this suggestion has not been followed as much as it deserves, and attention is again directed to its great utility. Possibly an incentive to more extended use is the author's procedure for determining this ratio when only the simple roentgenogram is available.

KRONTOWSKI, A. A. On the analysis of the roentgen-ray effects on the embryo and embryonal tissue. *Strahlentherapie*, 1925, xxi, 12–30.

Tissue cultures of chick embryos are able to grow after roentgen irradiation *in vitro* with doses that exert a distinct inhibiting effect upon cultures of lymphoid tissue, e.g., from the spleen of adult rabbits. After irradiation of the explants *in vitro* with rather considerable doses, tissue cultures exhibit good growth not only of mesenchyme but also of ecto- and endodermal epithelium. On the other hand, chick embryos receiving the same or even smaller doses of rays are quickly killed whenever eggs containing the embryos are irradiated.

Special experiments were performed to explain the above contradictory phenomena. If eggs containing embryos are irradiated with fatal doses and tissue cultures are made from these embryos, it is found that certain tissues remain viable and are able to grow in tissue culture. Such cultures from various tissues of dying or already dead embryos showed good growth of the mesenchyme and of the epithelial tissues of ecto- and endodermal origin. For instance an explant was made from a dead embryo heart in which the rhythmic contractions were restored and carried through three passages, the growth and rhythmic contractions continuing for eleven days until the experiment was accidentally stopped.

The experiments demonstrate, therefore, that although in irradiation of embryos the various embryonal tissues are all exposed to the effects of the rays, one must not conclude in case the embryo dies that the dose administered is necessarily directly fatal to all embryonal tissue. Although the embryos were found to be very sensitive to roentgen rays, the individual embryonal tissues examined showed relatively slight sensitiveness to the primary action of the rays, not only when irradiated *in vitro* but also after irradiation *in vivo*. In the latter case the actual primary direct effect of the rays upon the embryonal tissues can be determined only by an explanation experiment so as to avoid secondary effects produced by the organism.

LAWSON, JOHN D. The treatment of pyogenic infection by roentgen irradiation. *Radiology*, February, 1926, vi, 153–155.

Very satisfactory results with a high percentage of cures are observed following roentgen irradiation of dermal infections due to staphylococci and streptococci, acute and chronic. Among the acute conditions are furunculosis, carbunculosis and cellulitis; the latter may be subdivided still further into the erysipeloid and phlegmonous types. The chronic pyogenic infections most frequently met with are acne, pustular dermatitis and infected granulomata. All of these conditions with the exception of phlegmonous cellulitis have been treated at the Woodland Clinic, Woodland, California, with excellent results.

Probably less than 10 per cent of practising physicians know that boils and such processes can be effectively arrested by roentgen-ray therapy. The advantages of irradiation over surgery are: (1) the natural defense barrier is not disturbed by irradiation; (2) there is no danger of a new type of infection being introduced; (3) the treatment is painless; (4) there is prompt relief from pain; (5) there is no ultimate scar. Furuncles and boils, in general, yield much more rapidly to roentgen therapeutic measures than to any other type of therapy. In irradiating a boil some of the surrounding area is included in the treatment thereby preventing the usual "crop."

Another type of acute infection which should never be treated surgically is the group of lesions of the face above the mouth. There is a danger of causing meningitis; and incision

and drainage rarely constitute a satisfactory form of treatment. Fifteen cases have been seen by the author which have responded satisfactorily to long wave therapy.

The earlier an acute lesion is treated the more prompt is the result and the more likely is a cure without suppuration. Treatment after suppuration has begun will shorten the length of time that would ordinarily be consumed in controlling the lesion, and discomfort and pain are relieved quite promptly. If suppuration is already present and there is a pocket of pus, this should be evacuated surgically, but the irradiation should also be applied at the same time.

Five cases of erysipelas have been treated by long wave irradiation, all of which yielded promptly. There was no progression of the disease after roentgen treatment was instituted.

The technique used in the treatment of all acute processes and infectious granulomata consists in administering a full erythema dose of unfiltered rays, the voltage varying from 70 to 100 kv. There seems to be a peculiar condition in these cases in that 2 or even $2\frac{1}{2}$ erythema doses may be given to a patient within a week without the usual signs of skin irritation or damage. If there is not complete subsidence of the lesion or at least a very marked subsidence after forty-eight hours, another irradiation of one-half erythema dose is administered, this being repeated again if necessary at the end of another forty-eight hours. In the treatment of chronic types, the same factors may be used except that about one-quarter of an erythema dose is given at intervals of three days for three doses, after which time about one-sixth of an erythema dose is given weekly.

MADDOCK, STEPHEN J., and WHITAKER, LESTER R. Effects of sodium tetraiodophenolphthalein in complete biliary obstruction. *Boston M. & S. J.*, May 27, 1926, excv, 973–976.

Since Abel and Rowntree have shown that this substance under normal conditions is excreted almost entirely by the liver, it is of vital interest to know what effects the drug might have if the common bile duct should become occluded. Some of these effects were studied upon cats and dogs in whom biliary obstruction was accomplished by ligation of the common bile duct close to its entrance into the duodenum.

In complete obstruction of the common bile duct no roentgenographic shadow of the gall-bladder is obtainable with sodium tetraiodophenolphthalein. Normal animals after intravenous injection of the sodium salt excrete small amounts in the urine and large amounts in the feces. Animals with complete biliary obstruction, on the other hand, excrete considerable amounts in the urine and also large amounts in the feces. Probably on account of this vicarious elimination, the lethal dose of the drug in animals with complete biliary obstruction proves to be only 20 to 30 per cent below that for normal animals. This dose is relatively, per kilo, four to five times that necessary to produce a shadow of the gall-bladder in man. Furthermore, the damage to the liver produced by sublethal doses though somewhat more severe in obstructed than in normal animals is readily repaired.

In all probability then, there need be no fear of a fatal outcome from the intravenous use of sodium tetraiodophenolphthalein for cholecystography in a patient who might happen to have a complete biliary obstruction.

MACHT, D. I., and KRANTZ, J. C., JR. Photopharmacology. IV. Effect of radiation on digitalis. *Proc. Soc. Exper. Biol. & Med.*, February, 1926, xxiii, 340.

The effects of various radiations on the potency and keeping qualities of digitalis were studied, the official tincture of digitalis being used in the experiments. It was found that the shorter wave lengths, that is those less than 2,800 A, were more active than the longer ultraviolet rays.

Samples of tinctures were exposed to roentgen rays and radium directly, and to radium emanation. It was found that the roentgen rays and radium emanations produced destructive changes in the tincture so far as pharmacological potency was concerned. Heat rays also produced considerable deterioration.

MARKOVITS, EMMERICH. Contribution to the experimental radiation biology of cancer. *Strahlentherapie*, 1925, xxi, 81–90.

Greater radiation sensitiveness is found in cells not only at the time of their most active cell division, but also at the time of their slowest multiplication. It would seem that those cells undergoing *indirect* division show the greatest radiosensitiveness during the period of their most active division, and the cells undergoing direct division at the time of their slowest proliferation. For instance, the author observed *Paramecia* to be much more resistant to irradiation during the period of greatest cell division activity than in periods of slower growth. All the evidence seems to indicate that cells will show the greatest sensitiveness to radiation at the time when they are occupied with the difficult task of rearranging the chromatin of the chromosomes, and not at the time of greatest

preparedness for cell division or during the process of division.

The explanation of a better effect of fractional, but not very small, doses upon malignant tumors may be seen to lie in the fact that fractional treatment, which is generally more suitable than the single treatment, catches the cells at the various stages, during indirect division in the stage of karyokinesis, during rearrangement of the chromosomes, and during direct division in a stage of temporary, very sensitive disintegration and degeneration of the chromatin occurring simultaneously with the birth of the daughter cells.

PETROW, N., and KUSMINA, E. Experimental and clinical studies on the insertion of radium emanation in normal tissues and in tumors. *Deutsche med. Wchnschr.*, Apr. 9, 1926, lii, 622–624.

The authors have had an experience of about one year with the effects of radium emanation. The material was prepared at the Radium Institute of the Academy of Sciences in Leningrad from radioactive ores found in middle Asia. The emanation used in the experiments was contained in glass tubes 1 to 1.5 cm. long and 1.2 mm. in diameter; this size is considerably larger than the bare tubes (0.3 mm. × 0.5 cm.) customarily employed in America.

The emanation tubes were inserted into various animal tissues and organs and tumors. The tubes were allowed to remain for one day to five weeks, and the tissues were then removed for microscopic study. The results obtained confirm similar work already reported by others. Tubes containing 1 to 2 mg. emanation buried in guinea pig muscle for one to three days caused a distinct homogenization of the muscle cells directly adjacent to the glass tube, together with commencement of round cell infiltration and small extravasations of blood. Otherwise the appearances were normal. After five days' exposure the effects were more pronounced. The infiltrating round cells showed signs of break down and the amounts of extravasation were greater. Signs of early muscle cirrhosis were in evidence. An exposure for eight to twelve days caused a considerable amount of necrosis and there appeared numerous giant fibroblast-like cells originating from either the perithelial elements or sarcolemma nuclei. After the second week these cells decreased rapidly and scar formation commenced around the necrotic zone. The above mentioned giant cells were never observed in the case of rabbits. The point to be emphasized is that these observations show not a mere cauterizing action of the beta and gamma rays from the emanation but something more. A distinct incubation period of about three days was noted before the appearance of any effect, and different tissue elements showed themselves sensitive to the rays to different degrees. For instance, vascular endothelia, muscle cells, skin and mucosal epithelium broke down under the influence of the radiations much more rapidly than did connective tissue elements.

On three different occasions spontaneous mouse carcinomas of about 1 cm. diameter received a 1 mg. emanation tube inserted into the center, and in all three cases the tumors contracted and disappeared completely. The animals were sacrificed after a month, and the microscopic examination disclosed the typical changes found in animal tissues, i.e., necrosis in the immediate vicinity of the tube and scar formation round about. In one of the cases not a single cancer cell could be found; and in the other two, small nests were found in the periphery of the former tumor within a cicatrized connective tissue. All the above effects were produced with quantities of 1 to 2 mg. emanation.

A further series of experiments was performed to determine the effect of much smaller quantities; and 0.1 to 1.0 mg. emanation in glass tubes was introduced subcutaneously into rabbit ears and allowed to act for five, fifteen, thirty minutes, etc. Here also a very distinct incubation period was noted before effects made themselves evident. These small irradiations caused a rather remarkable proliferation of the connective tissue and epithelium. This proliferation was among the fibroblasts and was in spots suggestive of sarcoma, the fibroblasts growing into the subcutaneous connective tissue and invading and destroying the ear cartilage. In the case of the epithelial proliferation the appearance suggested the pre-cancerous stages seen after tar painting.

In the authors' clinical practice they have employed their rather large emanation seeds, inserting the tubes so that each cubic centimeter of tissue is irradiated by 1 mg. of emanation. Insufficient time has elapsed for a statement of the results, but satisfactory progress in many cases has been noted.

ROCHLIN, G., and GLEICHGEWICHT, EMILIE. The problem of the biological effect of roentgen rays. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 971–980.

Under the influence of small doses, seedlings of *Phaseolus vulgaris* showed an increase in the energy of cell division, an acceleration in growth and tissue differentiation and a

prompter regeneration. These phenomena were not followed by a compensatory inhibition. Under the influence of large doses these seedlings in six hours exhibited complete disappearance of cell division figures and the appearance of degenerative changes in the nucleus, nucleolus and plasma. In addition to these pathological changes, abnormal mitoses were observed four days after irradiation.

The authors also confirmed the fact that various plant species show different sensitivity to the roentgen rays, and in plants of the same species there is a variable individual sensitivity. In the case of horse beans (*Vicia faba equina*) the threshold of sensitivity is so low that they are useless in studying any possible accelerating action of the roentgen rays. *Phaseolus vulgaris*, on the other hand, possesses a sufficient degree of resistance to serve as a test object.

The instrument used in making the experiments was a carefully standardized apparatus with tubes of known characteristics, operated at 2 ma., 75 kv., filtration through 1 mm. Al, distance from the focus to the surface of the test object 20 to 23 cm. The stimulation of the seedlings noted above was obtained with doses of one-third to one-fourth skin unit dose. Doses of 1.5 skin units and higher were distinctly detrimental.

Schneider, Erich. To what is due the slight biological effect of roentgen rays upon unicellular organisms? *Klin. Wchnschr.*, Jan. 15, 1926, v, 97–99.

It is well known that unicellular organisms show very much less sensitiveness to radiations than do higher organisms. The explanation for this may be found in the fact that the individual cell of this class of organisms is very much more independent of its surroundings than the cell in a cell group constituting tissue. An important point of attack of the roentgen rays is upon intercellular material in the surrounding medium and this factor is of a lower order of magnitude in the case of the unicellular organisms.

Wucherpennig, V. The effects upon the dose in superficial roentgen therapy caused by variations in the circuit voltage. *Klin. Wchnschr.*, May 21, 1926, v, 942–943.

Measurements were made on the low power Heliodor apparatus. The quantitative measures of the roentgen rays were made with a Friedrich dosimeter and the qualitative with a Seeman spectrograph. Comparisons between the current voltage and the spectrographically measured voltage at the tube showed that with increasing circuit voltage the tube voltage decreased at a higher rate. The differences, however, were comparatively low. Measurements on unfiltered radiation showed that the roentgen-ray dose decreased twice as fast as the drop in voltage. In the case of radiations filtered through 2 mm. Al the discrepancy was still greater; with a drop of 5 per cent in voltage the dose decreased 16 per cent; a drop of 12.5 per cent in voltage corresponded to a decrease of 37.5 per cent in the dose. Examination of the spectrograms showed that although there was a general effect upon the whole spectrum, the softer rays were affected to a greater degree. Under the conditions of operation the soft rays were mostly absorbed by the glass walls of the tube.

Since in most localities a variation of at least 5 per cent in the voltage of the circuit may be expected, the error involved may be 20 to 30 per cent for filtered roentgen rays. The soft rays are sought in superficial roentgen therapy and it is seen from the above that important errors in dosage may be introduced by comparatively small variations in the power supply. Consequently voltage control must be just as carefully practised as in deep therapy. Since present-day low powered apparatus is not furnished with voltage regulators the author suggests the following arrangement: There is introduced an accurate voltmeter in circuit with a simple variable resistance. With the aid of this the voltage can be maintained at a definite level. Any dose can thus be controlled and reproduced. Once the primary voltage is controlled the readings of the milliamperemeter, which are much more accurate, can be made to serve as the true indicator of dosage.

Zappert, J. Has the roentgen treatment of the pregnant mother a harmful effect upon the child? *Wien. klin. Wchnschr.*, June 11, 1925, xviii, 669–673.

So far as concerns human beings, irradiations of the ova do not appear to be dangerous and as a rule do not affect pregnancy or the health of the offspring of the irradiated mother. The effect upon the fetus *in utero* is still the subject of discussion. The author has made a survey of available literature and has collected 21 observations that have to do with the possibility of injury to the fetus by irradiation. In less than half of these cases "normal" children were born. Most of the children were born under-weight and several times other signs of prematurity were present. In a relatively large number of the cases there was present malformation of the brain in the sense of a microcephaly, and several times there was

simultaneous microphthalmia. A point that is considered noteworthy is the fact that those cases which were carefully and accurately observed showed a greater percentge of pathological changes than those which were casually observed and reported.

BECCHINI, GASTONE. The large movements of the colon are pathological. *Arch. di radiol., Naples*, Jan-Feb., 1926, ii, 50–56.

Among the different movements of the colon described by different authors in serial pictures Holzknecht in 1909 described what he called "large movements," which he thought were physiological and which he attributed to propulsion of the mass of intestinal contents. Since then Schwarz, Case, Fischl and other authors have described these movements and have also considered them a normal part of the function of the colon, although they are rare.

The author describes 3 cases in which he saw movements which presented all the characteristics of these large movements. They were all pathological cases, the first one of chronic appendicitis, the second of chronic appendicitis complicated by mobile cecum and Jackson's membrane, as shown by operation, and the third of mucous colitis. From the extreme rarity of these movements, which he thinks would be seen more frequently if they were normal, and from the fact that the only three times he has seen them they were in pathological cases, he believes that they are pathological and not physiological. From the facts observed in his cases and the added fact that they are sometimes seen after opaque enemas he thinks that they probably represent a response of the motor elements of the intestine to abnormal stimuli of one kind or another.

CERNÉ, A. The vascular pedicle of the heart. *J. de radiol. et d'électrol., Par.*, January, 1926, x, 1–13.

Up until recently anatomical studies have been based almost entirely on dissection, and death makes such radical changes in the heart and vessels that they have been very inaccurate. Even with roentgenology it has been hard to get accurate details because of the superimposition of many shadows. The author gives three diagrammatic cross sections of the thorax, one at the level of the line between the 4th and 5th dorsal vertebrae corresponding to the middle of the horizontal part of the aorta, one at the middle of the 6th dorsal, corresponding to the upper part of the pulmonary artery and its two branches and the third at the middle of the 7th dorsal, corresponding to the foot of the pulmonary artery, the left auricle and the pulmonary veins; he also gives three vertical outlines, showing the heart and large vessels, the trachea and large bronchi, one from in front and the others taken obliquely at an angle of 50° right and left.

The position of the aorta is generally described in relation to the sternum but the author describes it with relation to the median shadow, that is the shadow of the bodies of the vertebrae. In roentgenoscopy in the majority of cases whatever the age and sex of the subject the pulsation of the ascending aorta is visible along the right border of the median shadow or passes beyond it. It is only exceptionally that it requires a slight rotation to the left to free it. He thinks it certain therefore that the right border of the aorta normally touches and in the majority of cases passes beyond the median shadow. The left border of the ascending aorta is hidden by the pulmonary artery and cannot be seen. What he calls the semicircle is formed by the horizontal curvature of the arch. The shadow below the semicircle which generally passes a little obliquely downward and inward he thinks does not represent the beginning of the thoracic aorta but the end of the arch which logically should terminate where the aorta joins the shadow of the vertebral column, at about the line between the 5th and 6th vertebrae. There is where the vessel, which was before oblique downward, backward and inward takes a vertical direction or even one a little obliquely forward. The classical method of locating it by means of the oblique left bronchus is incorrect. Roentgenologically the upper boundary of this terminal part of the arch, about 1.5 cm. long, runs horizontally along the upper border of the pulmonary. But if the trunk of the pulmonary is small or the descending aorta is large, a certain part of the descending aorta becomes visible for a variable distance.

It is quite generally agreed that the middle of the left heart boundary is formed almost wholly by the pulmonary artery; Vaquez and Bordet are the only authors who say that the greater part of it is formed by the left auricle. But many authors show it as a slightly concave line instead of a convex one as the left border of the pulmonary artery should be. There is a good deal of difference of opinion as to the visibility of the superior vena cava but the author agrees with Béclère that it is rarely if ever visible. He believes that the line oblique upward and inward which many take to be the right border of the foot of the vena cava is really the right auricle.

In the right anterior oblique position the ascending and descending segments of the aorta are superimposed in front of the shadow of the vertebral column at an angle of 20°,

after which the shadow of the descending segment becomes detached from that of the ascending; they become tangent to each other at between 35° and 40° and then separate from each other. At 50° and even up to 60° the overriding of the vertical vascular shadows prevents their being individualized and the confusion is rendered still greater by the horizontal part of the right pulmonary artery. The posterior border of the ascending aorta itself, infringed upon by the left bronchus, does not become distinct until toward 50°. Many roentgenologists in discussing the dissociation of the ascending and descending segments of the aorta have described the appearance of a darker shadow in the retro-aortic space beginning at 35° which they take to be the shadow of the vena cava. But the vena cava which is situated almost completely at the right of the descending aorta cannot appear during rotation to the right; to do that it would have to be situated behind and to the left of it. It is still harder to see how Vaquez and Bordet can describe this so-called shadow of the vena cava becoming dissociated from the aorta, the pulmonary artery appearing between them, at 45°. In any position whatever the vena cava cannot help being either tangent to the aorta or partially covering it or being covered by it. Their dissociation in roentgenograms of cadavers can only be explained by the presence of liquid in the pericardium. The inconstant and irregular reinforcements of shadows so frequently seen are due to very complex superimpositions. It is surprising that the outlines of the left auricle cannot be seen. Theoretically its thickness should render it very clearly visible, but it is really hidden in the shadows of the pulmonary vessels which cross it in various directions.

The shadow of the hilus is made up predominantly of the shadows of the pulmonary arteries, but though the bronchi are generally ignored their cartilaginous outlines can generally be seen as straight lines or in the most favorable cases in the characteristic rosary form. Their shadow reinforces that of the vessels and they form those small, clear shadows the significance of which has been so much discussed. The spots which are larger and less clear may be formed by glands or the crossing of vessels.

DOGNON, A. Measuring the biological action of roentgen rays of different wave lengths. *J. de radiol. et d'électrol., Par.*, 1926, x, 145–151; 210–218.

The author studied the results obtained on observing the action of three wave-lengths, $\lambda = 0.22$, $\lambda = 0.70$ and $\lambda = 1.54$ U. A. on the eggs of *Ascaris megalocephala*, on which very accurate quantitative studies can be made.

He found that with an equal amount of energy absorbed, ionization being utilized directly as a measure of energy, the action of radiations of different wave lengths on ascaris eggs is not constant. Its minimum action is at $\lambda = 0.70$ U. A. and it increases toward the shorter and longer wave lengths. The action of $\lambda = 1.54$ U. A. being represented as 1, that of the radiations $\lambda = 0.22$ and $\lambda = 1.54$ U. A. are represented respectively by 2 and 1.5. These results are in definite contradiction to the theory of equal action for equal energy and it is consequently contradictory to the results obtained by Holthusen, using the same objects for experiment, a discrepancy which may be partially due to the difference in the irradiation used, which in the author's experiments was homogeneous and the wave lengths studied not so nearly alike, but it is probably due more to the difference in the basis of measurement.

Dognon has shown that for short wave lengths a dosage brought about in an air ionization chamber does not measure directly the intensity absorbed by the objects for different frequencies, although this is a hypothesis that is admitted without discussion by the authors who have performed similar experiments. He does not believe, however, that the results which he has obtained can be generalized. It seems certain that different cells behave differently to rays of different frequency. It is possible that this is due to functional characteristics of the cells, and that the greater the activity of the cell the greater its sensitiveness to rays of short wave length. In fact he has shown in another article that ascaris eggs irradiated at a high temperature show increased radiosensitiveness, which is increased relatively more for short than long waves. There are other facts that may be interpreted in the same way, for instance the observation of Reiss that the nucleus is relatively more sensitive to short wave lengths than the protoplasm.

There are two possible ways of representing the action of rays with regard to wave length. The first is to assume that there are two distinct modes of action of the rays, increasing from a minimum toward both the shorter and longer waves. The curve is simply the result of two functions acting in opposite directions. Or it may be supposed that there is a difference of response to different wave lengths not only in different kinds of cells but in the different component parts of the same cell, and so the total action observed would be the resultant of a certain number of different degrees of radiosensitiveness, which would be expressed by a

very complex law. And this law would hold good only for the one kind of cell, not for all cells. The theoretical explanation of these phenomena is too vague and too far beyond present actual knowledge to be of any interest.

HEUSER, CARLOS. Table for roentgen examination in urology. *Semana med., Buenos Aires*, Feb. 18, 1926, xxiii, 368–372.

The author shows by means of illustrations a special table for roentgen examinations in which the patient can be roentgenographed in any position, sitting, reclining, semi-reclining or Trendelenburg. The table stands beside the support for the Potter-Bucky diaphragm and pictures of any desired part of the body can be taken in any of the above positions. To get a good picture of the posterior urethra and the lower part of the bladder the patient is placed on the plate after having emptied his bladder. The right leg is extended to the right as far as possible, since if it is allowed to hang down it changes the position of the urethra; the left leg is then flexed as far as possible as if the patient were going to step up a high step. In this position the opaque liquid is passed into the bladder and at the moment the picture is taken the patient is told to urinate; with a little practice very good pictures can be obtained of the lower part of the bladder, the sphincter and the whole course of the posterior and anterior urethra.

GALLINO, MARTIN MIRANDA. Teleroentgenographic examination of the heart and its vascular peduncle. *Semana med., Buenos Aires*, Feb. 25, 1926, xxxiii, 421–424.

Köhler found that the divergence of the rays of the roentgen cone which causes the distortion and enlargement of the picture of internal organs taken at short distances, decreases as the target is moved farther from the plate, and when it reaches a certain distance the divergence is so small as to be negligible practically. Different authors have given various distances which they held were necessary to correct the distortion, varying from 1.50 to 3.50 meters.

In order to settle this question the author made a lead model of the heart and vascular peduncle with the measurements normal for a man thirty to forty years of age, weighing 60–70 kilograms and 1.60 to 1.70 meters tall. He examined it with the target at various distances from the plate, keeping the model always at a distance of 9.5 cm. from the plate and letting the normal ray fall always in the middle of the base of the heart. Under these conditions with a focal distance of 1.50 meters there was an enlargement of 7 mm. in the transverse diameter of the peduncle, of 3 mm. in the chord of the arch of the aorta and of 9 mm. in each of the diameters of the heart. At a distance of 3.5 meters there was an enlargement of 2.5 mm. in the transverse diameter of the peduncle, of 1 mm. in the cord of the arch of the aorta and of 2.5 mm. in the two diameters of the heart. He came to the conclusion that between 2.50 and 3 meters the differences were slight enough to be disregarded practically in the normal heart. But of course with an enlarged heart the distortion at a given distance would be greater than with a normal one. In some cases of very much enlarged hearts he has found enlargements of as much as 12 mm. in the diameters of the heart and of 8 mm. in the diameters of the peduncle, as compared with the orthodiagraphic picture. In cases of enlarged heart, therefore, the distance chosen for teleroentgenography should be 3.5 meters. With modern apparatus it is possible to get clear teleroentgenograms at this distance.

HOLBEACH, C. H. The use and abuse of radiator Coolidge tubes. *Brit. J. Radiol.*, January, 1926, xxii, 20–22.

A roentgen tube with a molten target is considered irreparable, and therefore precautions should be taken never to exceed the limit specified by the manufacturer. The user of the modern Coolidge tube takes it too much for granted that it will stand anything because it will apparently stand a large amount of over-running without permanent damage.

In use, the radiator type tube is limited by the thermal capacity of the copper anode and stem. It is for this reason that strict limits are imposed upon the operation of these tubes. At 30 ma. with a 5 in. spark gap between points (85 kv. peak) the duration of a single exposure should not be in excess of 20 seconds, operating from cold.

The greatest danger lies in the practice of running these tubes for prolonged periods for screening purposes followed immediately without a rest interval by a series of roentgenographic exposures at the full current rating.

An experiment is cited in which it is shown that a tube may be over-running 400 per cent before destruction.

LENTZE, F. A. Gallstones and gall-bladder carcinoma. *Beitr. z. klin. Chir.*, 1926, cxxxvii, 38–62.

A statistical analysis of the reports from various clinics shows an undoubted causal

relationship between gallstones and carcinoma of the gall-bladder. The figures, however, do not permit a conclusion as to which of the conditions is the primary one. Even though such a proof is absent nevertheless the probabilities are all in favor of the idea that the gallstones appear first.

There is therefore in gallstone carriers at the age of forty a not inconsiderable danger of the development of a subsequent cancer of the gall-bladder; and this hazard increases with the years. These considerations consequently should be kept in mind when weighing the various factors influencing the indication for operative removal of the gall-bladder.

Mottram, J. C., Scott, G. M., and Russ, S. On the effects of beta rays from radium upon division and growth of cancer cells. *Proc. Roy. Soc., Lond.*, Sept. 1, 1926, c. Ser. B, 326–335.

Experiments were performed to show how the growth and division of Jensen's rat sarcoma cells are affected by exposure to measured doses of beta radiation; and the results show that a rather close parallel exists between the sequence of changes after irradiation in cells of *in vitro* tissue cultures studied by Strangeways and Oakley, and that occurring in Jensen's rat sarcoma growing in a rat.

The action of the beta rays of radium upon tumor cells is complicated by the various phases of cell activity which are represented by growth and division. The cells of the Jensen rat sarcoma in a state of division suffer no immediate recognizable changes on exposure to large doses of beta radiation. The subsequent changes involving an absence of cells in active division are interpreted as being due to a temporary inhibition of maturing cells entering the phase of mitosis. The final changes which are profound enough to prevent growth of the tumor when inoculated may be interpreted as being due to the fact that eventually after a lethal dose of radiation the daughter cells are not capable of subsequent normal division.

The procedure in the experiment was to inoculate rats in the right and left axillae with the Jensen rat sarcoma. When small tumors measuring about 12 × 12 mm. had grown, a radium capsule containing 30 mg. radium bromide was held to the surface of one of the tumors for a specified time, the animal being under an anesthetic (the radium salt was contained in a circular silver box about 2 mm. deep and 1 cm. diameter fitted with a window of silver 0.1 mm. thick). When the exposure was over, a piece of tumor less than 1 mm. thick immediately below the skin in the middle of the part irradiated was removed for examination, and a similar piece from the control tumor. These were immediately fixed, sectioned and examined. Three series were carried out with exposures which represented one-half the lethal dose, the lethal dose and twice the lethal dose. The actual length of time for the radium exposures were 0.5, 1.0, and 2.0 hours, respectively.

Mazeres, M. Primary gamma irradiation around a linear source of radium. *J. de radiol. et d'électrol., Par.*, April, 1926, x, 159–163.

Experiments in photographing the irradiation around radium tubes and needles showed that around a radium tube the irradiation is asymmetrical. The irradiation is almost zero along the longitudinal axis on the end where the eye is and there is strong irradiation along the axis of the opposite end. The surfaces of equal intensity revolve around the tube and are umbilicated toward the ends. Near the umbilications there are zones of low dosage shown by the photographic test. The surfaces of isodosage are not ovals of revolution around the longitudinal axis of the tube.

There is symmetry around a radiating platinum needle; the surfaces of equal intensity are umbilicated in the same way, as the needle does not irradiate along its axis. Following the longitudinal axis of the source on the end without an eye the primary intensity at a given point depends on the distance of the point from the two extremities of the tube. Outside the longitudinal axis the primary intensity at a given point depends on the distance to the tube and the angles formed by the tube and the straight lines passing from the point to the two ends of the needle. In application to multiple foci there are zones of hypodosage due to the shadows cast.

Neu, L. Some characteristics of the electrical resistance of the skin. *J. de radiol. et d'électrol., Par.*, May, 1926, x, 219–223.

The variations in apparent resistance of living tissues during the passage of a continuous current are well known and have been studied in electrophysiology. The author studied the electrical resistance of the human skin after the passage of a current for a relatively long time. To measure the resistance of different subjects he made use of Wheatstone's bridge method. The points chosen for measurement were the dorsal surface of the forearm and the anterior part of the neck.

The electrodes were two plates of zinc 10 sq. cm. in area fixed on the skin under slight pressure. Two layers of paper the same size as the electrodes were placed between the skin and each electrode. One was soaked with physiological salt solution and placed on the skin, the other was saturated with zinc sulphate and placed between the first one and the metal electrode. These electrodes proved practically impolarizable and did not change to any appreciable degree the high resistance noted in the subjects. As a source of current he used two accumulators with a total force of about 4 volts, which made it possible to avoid any considerable lowering of resistance during the passage of the current. Tables are given showing the results of the experiments.

He saw the well-known phenomenon of lowering of resistance as the current was prolonged. But he also observed a phenomenon which he thinks has not been described before, namely that when the current is stopped the resistance not only returns progressively to its former value, as was to be expected, but in a great majority of the cases it passes beyond that value and reaches a maximum, after which it decreases slowly to the original value. Curves are given showing the increase of resistance. The question arises of whether the increased resistance is due to a change in the polarization. With this method he cannot answer this question definitely, but the fact that the increased resistance is lowered during a new passage of the current would argue that it is. Prolonged compression of the skin produces a similar reaction.

OPITZ, E. The biological basis of the radiation treatment of carcinoma, especially that of the uterus. *Strahlentherapie*, 1926, xxi, 353–367.

The reason why purely chemical processes can be observed only relatively infrequently as the direct effect of irradiation lies in the colloidal constitution of protoplasm and the body fluids. A labile structure as exemplified in the leucocyte and lymphocyte will quickly reveal the effects of irradiation by a destruction of the whole cell interior because of the great reaction velocity involved. On the other hand, other cells show practically no effect or only gradual changes after very high dosage, apparently because their structure is considerably more stable and not so easily destroyed by the removal of one or another micelle. It is therefore the important characteristics of the cells themselves, presumably in their disperse phases primarily that condition the different degrees of sensitiveness and speed of response to roentgen irradiation. The same considerations apply to the cells comprising any single tumor. They are of all ages and degrees of development and may be expected to show corresponding differences in response to the roentgen rays.

The problem involved in the treatment of cancer by radiation is a biological one. Histologically, we find in cancer undergoing spontaneous regression exactly the same processes that can be observed after roentgen irradiation. There is evidence that the body sets in motion defense measures which in the majority of cases do not seem to be adequate for controlling the disease; consequently in order to cure cancer with our present means which includes irradiation, it is necessary to marshal all the forces of the body. The first requirement is naturally a very carefully developed technique of irradiation. But equally important is as full a knowledge as possible of the biology of the cancer itself. The latter must include not only the disease focus but certain changes in the vegetative nervous system and other bodily functions.

In the treatment of carcinoma of the uterus the author's main reliance is in the treatment with radium or mesothorium. Each case must be judged individually and the method of radium application correspondingly adjusted. In the majority of cases the radium is administered through a long filter inserted in the cavity of the uterus. In addition, roentgen treatment is applied through large fields in order to augment the relatively slight general effect of the radium rays. The dosage is of very great importance and should take into consideration the previous total amount of irradiation from the radium. The roentgen treatment is guided by the blood picture and the sedimentability of the red cells. Irradiation is stopped when a leucopenia occurs in the peripheral blood (5,000 leucocytes or less), and also when a decided lymphopenia is present, that is, when lymphocytes drop below 20 per cent.

It is emphasized that satisfactory nourishment and production of a favorable hygienic condition of the patient is as important in the treatment of cancer as in the treatment of pulmonary tuberculosis.

PACE, DOMENICO. Anatomical-roentgenological study of the coronary artery of man and mammals. *Arch. ital. di anat. e di embriol.*, July, 1925, xxii, 247.

In order to study the question of whether there are anastomoses between the right and left coronary arteries and the origin of the blood supply of the different parts of the heart the author injected a number of hearts with opaque

substance and took roentgenograms of them. He emphasizes particularly his study of the different segments of the heart separately. He studied the hearts of three horses, two lambs, one goat and two men. Twenty-two roentgenograms showing the distribution of the blood supply of various segments of the heart are given. He found the sinus node supplied sometimes from the right coronary and sometimes from the left. Crainiciann, a Roumanian author who has recently studied the subject exhaustively, gives 25 per cent for the left coronary, 68 per cent for the right and 7 per cent supplied by both coronaries. It might be supposed that the specific tissue which has the high function of transmitting stimuli would require a copious blood supply; in fact, the bundle of His is supplied by one small arteriole. The left ventricle, which is the motor power of the heart, is the part that requires the richest blood supply and it is very abundantly supplied with vessels; the automatic centers of the heart are mere islands in the heart muscle with little need of nutrition and a scanty blood supply.

The author believes that if there were free anastomosis between the right and left coronary arteries the whole of the interventricular septum would be injected when either the right or left coronary artery was injected. He found that when the left coronary artery was injected the opaque substance could be seen only in the left half of the septum but that no shadow appeared in the half of the septum supplied by the right coronary artery. He found this both in the hearts of horses and of men. Crainicianu shows a heart with the interventricular septum penetrated by perforating branches, but he does not think this is conclusive, as it may be a question of branches superimposed on each other and not of ones anastomosing with each other. This question, which is important in physiology as well as anatomy, still remains open, and he considers his work only a preliminary study.

Solomon, I. Suggestion for an international quantitative measure of roentgen rays. *J. de radiol. et d'électrol., Par.*, April, 1926, x, 155–158.

A number of methods of measurement suggested have been based on electrostatic units. In 1920 in his first work on ionometry the author proposed a unit R which he defined as follows: the intensity of roentgen irradiation producing the same amount of ionization as a gram of radium element placed at 2 cm. from the ionization chamber and in the same axis and filtered through 0.5 mm. platinum. A roentgen ray producing the same ionization as a gram of radium element under these conditions has an intensity of 1 R per second, and the quantity of irradiation will be given by its intensity multiplied by the time of its application. In order to standardize the ionometric apparatus he would make use of a cylinder of lead with an exterior diameter of 5 cm. and an interior diameter of 4 cm. A platform inside carries the radioactive substance; an orifice at a suitable distance makes it possible to place the ionization chamber properly. The dimensions of the cylinder and the length and arrangement of the radio-active preparation may cause slight variations in the result of the standardization, but if necessary the whole standardizing apparatus may be made the subject of an international convention. He believes that all the objections that have been urged against the method can easily be overcome.

He believes that Behnken's R unit which has been quite generally adopted in Germany presents important practical difficulties and is not any more accurate than his. It requires standardization by very skilled physicians in a specially equipped laboratory. The author's R unit should be a multiple of the German R unit; this multiple has been found by Grebe and Martius to be 2.2. Certainly the two notations should be unified, aside from any question of priority because serious danger may result from confusing the two systems of notation. It ought to be easy to bring about this unification; it would only be necessary either to increase the volume of air ionized in Behnken's unit or increase the distance of the radioactive preparation in the author's. At any rate it is now possible to express the amount of irradiation in a notation which is independent of the operator and, within well-defined limits, of the measuring apparatus used.

Stephenson, R. J. A study of interrupters for induction coils. *Brit. J. Radiol.*, January, 1926, xxii, 13–19.

A comparison was made of the relative efficiencies of the mercury and electrolytic breaks when working on a roentgen-ray circuit. There are two obvious differences between these breaks (1) the electrolytic break is ready to make again immediately after breaking; (2) the electrolytic break never absolutely breaks, but interposes a high resistance, with the result that the primary of the induction coil circuit is always closed. This considerably changes the reaction between the primary and secondary of the induction. A circuit was arranged which included a large 16 inch intensifying induction coil, a current and voltage oscillograph and an electrolytic break. The secondary was closed through a

high water resistance in place of the usual roentgen tube so that there would be no necessity to use a Kenotron rectifying valve.

When the roentgen tube is operated on an electrolytic break the tube will not allow the current to rush through, with the result that a large amount of the secondary current is stored in the distributed capacity of the secondary, i.e., in the turns of wire near the center of the coil, which thus can produce a sufficiently large magnetic field to react on the primary current and prevent it completely breaking. So that, so long as there is a current flowing in the tube this reaction will continue and the primary current will only slowly come down to zero.

With a mercury break the primary circuit is absolutely broken but on the contrary, with the electrolytic break it is never broken, but a high resistance is interposed which is instantly destroyed by the spark. Immediately after the break takes place or the secondary current begins to flow the primary makes again, magnetizing the core, the induction from which pushes out the current from the secondary very quickly. With the mercury break there is no such tendency and a large part of the secondary current is taken up by the distributed capacity of the secondary and discharged at an almost constant rate.

STRANGEWAYS, T. S. P., and HOPWOOD, F. L. The effect of x-rays upon mitotic cell division in tissue cultures *in vitro*. *Proc. Roy. Soc., Lond.*, Sept. 1, 1926, c, Ser. B, 283–293.

It has previously been shown that when a tissue culture *in vitro* in which cell division is active is subjected to small doses of roentgen rays there occurs a decrease in the number of normal mitoses, and with somewhat larger doses a complete disappearance. These earlier experiments have been confirmed and extended. This inhibitory effect upon mitosis probably represents the most delicate and reliable test we have of biological response to irradiation.

The tissue used was obtained from the choroid and sclerotica of chick embryo of seven to nine days' incubation. The tissue fragments were grown in a hanging drop of mixed fowl plasma and embryo extract on a cover slip of soda glass which was sealed down with paraffin wax over a hollow ground soda glass slide. Cultures of the "second passage" which had been incubated from eighteen to twenty-two hours were used for irradiation. The radiations administered were varied as to hardness, and the dosage was carefully measured in terms of Friedrich's "e" (electrostatic) units. The complete dose in any case varying from 1 e to 160 e was given in a single exposure, the intensity being adjusted in each case to approximately 5 e per minute. From two to four different cultures were exposed simultaneously, and the number of mitoses in these as compared with controls was noted.

A series of experiments showed that if the cultures were stained immediately after irradiation no diminution in the number of cells in mitosis was found until, with a given intensity, a dose of 60 e had been given. Examination of cultures incubated for eighty minutes after irradiation, on the other hand, showed a definite decrease in the number of mitotic cells even after a dose of 1 e had been given.

These experiments again prove that the earliest recognizable effect of roentgen radiation upon growing cells is the temporary inhibition of the onset of mitotic division in the majority of those fully formed vegetative cells which are about to divide. Cells actually undergoing mitosis are unaffected by the irradiation. It appears that vegetative cells pass through a phase immediately prior to the visible prophase, during which the physiological processes of the cell are especially liable to be disturbed. If such a cell receives a dose of roentgen rays greater than 30 e, it will nevertheless enter mitosis but the process of division will be of an abnormal type and may result in complete disruption of the cell.

Variation in the quality of the incident beam of roentgen rays within the limits of the doses and times employed in these experiments appears to have no appreciable effect upon the results when the dose is measured with a small ionization chamber. If, however, the doses are measured by a "standard" air chamber, a possible increase in efficiency of nearly 40 per cent in favor of the longer wave lengths is suggested.

No evidence was obtained of any stimulating effect of roentgen rays on cell division.

ARNELL, SIGFRID. Three technical details. *Acta radiol.*, June 30, 1926, v, 284–288.

1. *How to extract silver from the fixing solution.* Silver may be recovered from used fixing solutions by placing in the bottom of the tank some copper plates which in forty-eight hours collect a black deposit of silver which can then be brushed off with a wire brush.

2. *A photographic marking for roentgenograms.* The author, in collaboration with Dr. Laurell, devised the following scheme for marking roentgen plates during exposure. Letters, arrows and other distinctive marks were fashioned of thin copper wire and these were fixed as needed to adhesive plaster, the whole being covered with a piece of cleaned

film. These marks were fixed on the cassette and exposed upon the film.

3. *A simple arrangement for covering the field to be treated while the anticathode is warmed.* The arrangement consists of a plate with a thick cover of leaded rubber fixed by a movable arm to a suitable stand. While the anticathode is warmed this plate is inserted between the tube and the field to be treated.

BAUERMEISTER, W. The duodenum as a mixing apparatus. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, January, 1926, xxxiv, 159–161.

Examination of the individual in the standing position shows that portions of the gastric contents travel through the relaxed pylorus into the bulbus duodeni. The fluid material travels passively to the vicinity of the suspensory ligament in the lower region of the duodenum. Undoubtedly, contractions of the intestinal wall assist in this movement but in general, at least, in the standing individual, it is passive. Part of the material then travels into the jejunum where it is subjected to the genuine peristalsis of the small intestine; another portion (and this is not unusual) is retained in the lower bend of the duodenum. This residue may be discharged shortly into the jejunum, or it may undergo a process which may be termed retroperistalsis. One may see some short preliminary contractions in the region of the sinus followed suddenly by an upward movement of the contents left in the lower duodenal coil. This material rises as if by one shove into the so-called vertical ramus, reaches the upper angle and passes beyond it somewhat, but hardly ever reaches as far as the bulbus region, and finally sinks again to the bottom with equal rapidity. This process may be repeated with the same duodenal contents if the latter are not ejected into the jejunum.

BIOGLIO, MARIO AUGUSTO. Biological and therapeutic action of the alpha rays of radium. *Arch. di radiol.*, Mar.–June, 1926, ii, 153–178.

The author has had an opportunity recently, through the courtesy of Mme. Curie to experiment with polonium, which is the only radioactive substance which emits alpha rays only. He found that the corpuscular alpha radiations have definite photographic and ionizing actions. When they come in contact with a metallic substance they give rise to secondary rays which are very penetrating. A detailed discussion of his therapeutic experiments with these rays is given from which he concludes that it is possible to construct apparatus of leather, wool, silk, felt and rubber which are homogeneously and permanently radioactive, and which make it possible to utilize the energy of the corpuscular irradiation, the radium emanation and the secondary rays (radium A, B, and C). These forms of apparatus have just the same qualities as those made of polonium, but they are preferable to the latter because of the duration and regularity of their action.

It is possible with these forms of apparatus to measure the total amount of energy used exactly and to stop the action of the radium at any time. The radiant energy is probably for the most part absorbed by the skin and certainly it is partly expelled with the urine. The therapeutic properties of the new apparatus are probably of two kinds; those due to the total primary energy and those due to secondary rays from metallic substances or the tissues, in contact with the apparatus. A more complete study of the latter is necessary before any definite opinion can be expressed in regard to them, but there is no doubt that the former have a local sedative action in all forms of rheumatism, neuralgia, arthralgia, neuritis, tabetic pain, etc. Alpha radium therapy with small doses does not give any pathological reaction in the urine, and is therefore relatively harmless.

The construction of such apparatus will permit of a much wider use of radium therapy in the above named conditions and in acute and subacute inflammations by the external application of radiant energy even at a distance from any radioactive source, such as emanations, mineral waters or mud, and at a relatively low cost. It will require further experiment to show whether this form of treatment will be useful in new growths or if it is capable of sterilizing the efferent lymphatics which drain the region of a tumor.

BRENZINGER, M., DESSAUER, F., and LORENZ, E. A universal direct current apparatus for roentgen diagnosis and therapy. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, January, 1926, xxxiv, 152–158.

The importance of constant direct current for the production of roentgen rays is generally recognized. Not only does it favor longer life of the tubes, but the total intensity of the radiation is increased and the intensity maximum is shifted somewhat toward the shorter waves. There have been suggested a number of direct current machines for therapy, but none has yet been devised for diagnosis.

The authors give a description of an installation which provides for high voltage therapy, and also permits change of potentials and currents to levels useful for diagnostic roentgenography.

For the production of direct current the authors make use of the Delon circuit. With the aid of specially constructed electron valve tubes and batteries of condensers arranged in parallel and in series it is possible to build up any voltage and current necessary for operation.

Beets, H. N., and Arens, Robert A. Ready reference tables for superficial roentgen therapy. *Radiology*, May, 1926, vi, 424–425.

The tables presented have been constructed from data contained in the literature. The skin unit (unfiltered rays) of Witherbee and Remer is used as the basis of dosage. Two tables are given. The first presents, without computation, the time required to deliver a skin unit of unfiltered or filtered radiation at a skin target distance of 15 inches under various conditions of milliamperage and spark lengths. The second table lists the commoner skin affections amenable to roentgen therapy, with the corresponding dosage.

Chantraine, Heinrich. The Siemens measuring device and the inverse square law. *Strahlentherapie*, 1925, xxi, 140–147.

In the Siemens apparatus furnished with the new measuring chamber, the readings taken at different distances agree with the values calculated according to the inverse square law (the rays falling vertically upon the chamber holder). The scattering effect of the air can be entirely neglected. Scattering by the lead can be definitely demonstrated but is also negligible practically. The size of the focal spot and the filter radiation also failed to produce any important deviation from the inverse square law under the conditions of the experiment. Consequently this law is an excellent means for checking the reliability of roentgen measuring instruments.

The new measuring chamber shows a directional effect. Radiations directed parallel to the chamber holder produce a reading 5 per cent greater than those directed vertically. By the use of this chamber, the measurement of most of the scattered radiation would be 5 per cent lower than the traversing primary rays. Since the surface dose in a field 6×8 consists of only 20 per cent scattered rays and 80 per cent penetrating rays and in the depth there is 70 per cent scattered radiation, the major portion of the depth dose is measured 5 per cent too high by this chamber. However, this effect is actually neutralized by a certain amount of absorption by the holder of the instrument. Another experiment in which the portal was 10×15 cm. demonstrated the same neutralization of effects. It may therefore be concluded that the depth readings given by the new Siemens chamber are essentially correct assuming that the size of the chamber introduces no important error. It appears very probable, however, that because of the not inconsiderable size of the chamber a somewhat larger depth dose will be registered than would be the case with a chamber of negligible size.

Chaoul, H. The iontodosimeter. A direct reading dosimeter for roentgen rays. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, January, 1926, xxxiv, 162–165.

The iontoquantimeter of modern construction is the only practical measuring instrument for roentgen rays devised up to the present. However, owing to the too short discharge time of the electrometer during measurements (several seconds) all variations occurring during operation cannot be accounted for. For this reason, calculated values of dose are more or less inexact and unreliable. These sources of error can be eliminated only when one employs an instrument which indicates progressively the increasing dose during the whole period of irradiation. Instruments hitherto devised with this purpose in view have not proven sufficiently precise or reliable.

The iontodosimeter devised by the author appears to satisfy all practical requirements. It consists of an iontoquantimeter, the discharge time of which is very much retarded by the employment of specially constructed condensers free from hysteresis. The discharge time has been so extended that when the ionization chamber of the instrument is fixed to the area to be irradiated and exposed to the rays, the time required corresponds to that necessary to produce a skin erythema dose with hard filtered rays. This device makes it possible not only to determine the dose with certainty but to control it throughout an irradiation. The dose may be determined at any moment without regard to the variations in conditions or variations in the operation of the machine. The scale of the instrument is divided into ten parts, and the divisions are so laid out that each one represents $\frac{1}{10}$ of a skin erythema dose. The progression of the pointer from 0 to 10 indicates that a complete skin erythema dose has been administered.

Crile, G. W. Surgical treatment of goiter. *Radiology*, May, 1926, vi, 365–367.

The plan of management employed by the author is such that almost no case of hyperthyroidism is too severe to warrant surgical treatment. During a period of six months from June 1, 1925, among 748 thyroidectomies for hyperthyroidism the mortality was 0.82 per cent, and among 398 ligations the mortality

was 0.76 per cent. By careful choice of the location of the line of incision the resultant scar is so slight that it becomes practically invisible within a few weeks. The one or two brief stays in the hospital do not inconvenience the patient more than the repeated visits to the hospital for treatment with roentgen rays. In the case of acute hyperthyroidism the patient's occupation should be interfered with and for a sufficient period no matter what the method of treatment may be. The problem of both roentgen therapy and surgery being to diminish the toxic secretions of the gland by diminishing the amount of the secreting substance, it appears to the author that surgery supplies the one method by which the amount of diminution can be definitely controlled. The amount of gland reduction by radiation therapy cannot be measured accurately. The argument of the roentgenologist that if roentgen therapy fails surgery can be employed later fails in one respect, for the difficulties of operation are increased by radiation and during the period of irradiation the disease has wrought additional damage.

Ernst, E. C., Chairman; Glasser, Otto; Stenström, Wilhelm; Dorsey, D. E.; Hunt, F. L.; Chamberlain, W. E.; and Erskine, A. W. Preliminary report of the Committee on Standardization of *x*-ray measurements. *Radiology*, March, 1926, vi, 191–197.

This report is by the Committee appointed by the Radiological Society of North America.

Without going into detail as to the relative merits of the various methods of measurement, the committee feels at this time that in all probability there are fundamental advantages in adopting the iontometric unit of roentgen-ray measurement. The weak point of this method is that the present type of measuring apparatus will necessarily require further standardization. It is suggested that the electrostatic unit "e" as suggested by a number of investigators is the most practical standard unit of measurement. A more exact definition of this unit is given in the "R" unit of the German Roentgen Society.

It is recognized that in connection with the quantity measurements of roentgen-ray output of any machine in standard units, it is equally essential to determine the quality of the radiation in terms of either the effective or the average wave length, the half value layer, or the coefficient of absorption. Charts for the deep intensity distribution of the human body should be very accurately determined.

When employing fairly hard rays in the average deep therapy treatment, 1300 "e" units have been observed to represent a dose which produces a skin reaction of the first degree. Radiation quality, however, has an important influence upon the number of "e" units necessary to produce the first skin reaction. For standardizing the output of different machines it is advisable to determine the number of "e" units in air, i.e., without back scattering, and to take the number of "e" units for the production of a skin dose from tables worked out for the special conditions in use.

Initial steps have been taken by the committee for a conference with the experts of the Bureau of Standards at Washington relative to the possibilities of standardization researches. A new deep therapy roentgen-ray equipment has been purchased for this special work. As soon as the necessary instruments are installed, the Bureau of Standards will welcome cooperation toward solving the problem of standardization by the establishment of a practical and uniform unit of roentgen-ray energy.

Fisher, N. F., Groot, J. T., and Bachem, A. The effects of *x*-ray on the pancreas. *Am. J. Physiol.*, April 1, 1926, lxxvi, 299–305.

A report is given of the effect of exposure of the isolated pancreas to measured doses of roentgen rays. Dogs were used in the four experiments. The animals were prepared as for the usual pancreatectomy and the head and body of the pancreas were completely removed. Beginning at the base of the duct of Santorini, the main pancreatic duct in the dog, the pancreas tissue was carefully removed for about 3 cm. from the base of the duct. The duct joining the main and accessory ducts was ligated. Thus was left sufficient of the tail of the pancreas to make up about one-third of the entire gland, with the main duct intact. The blood vessels going to the tail permitted the bringing of the remaining portion of the gland to the outside for irradiation.

The technique of irradiation was as follows: 150 kv. crest, 5 ma., 8 in. focal skin distance, through 4 mm. Al. Under these conditions 4.5 min. exposure produced a human erythema dose, represented by 450 R units of primary rays with an effective wave length of 0.27 A. Three, four or five erythema doses were applied to the surface of the tail third of the pancreas. The thickness of tissue was so small and the radiation sufficiently hard as to justify the assumption that the whole tissue was treated with the intended dose.

By the above means, it was possible to administer known amounts of roentgen rays to the gland without at the same time affecting other tissues. Administration of three erythema doses to the pancreas causes marked fibrosis

of the gland and results in diabetes. From this condition the pancreas can recover by proliferating new tissue from the periphery of the gland. Four or five erythema doses applied to the pancreas causes complete disappearance of the gland.

Polyuria without glycosuria developed in one dog on the third day following exposure to four erythema doses. Glycosuria was seen in one dog to the extent of 8.8 per cent without polyuria. One dog lived fifty-seven days with complete intolerance to carbohydrates, which is fifteen days longer than the maximum length of life reported for a pancreatectomized dog not receiving insulin.

FÜRST, WALTER. An aid in the exact placement of roentgen tubes for purposes of measurement and practical operation. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, January, 1926, xxxiv, 165–168.

An exact placement of the Coolidge tube is necessary in many cases and ordinarily it is done only approximately. The author describes a procedure for observing the direction of the central beam and then etching a spot on the glass wall so that in the future adjustments of the tube all that is necessary in determining the direction of the central beam is to project a line from the anticathode through the etched spot.

Two methods for fixing this spot on the tube wall are employed. The direct method employs an observation telescope with cross hairs directed in the line of the central beam which is made to pass through a cylindrical electrometer. The indirect method employs a fluorescent screen.

HANSON, ROBERT. On the development of spinal vertebrae, as seen on skiagrams, from late foetal life to the age of fourteen. *Acta radiol.*, Jan. 15, 1926, v, 112–126.

From late fetal life until the age of two, the vertebral body appears on the lateral roentgenogram as divided into three plates, the upper and lower ones being denser than the middle. In the anterior margin of the middle plate, there is seen a funnel-shaped excavation with the base directed forward. This excavation is occupied by a vein running close under the perichondrium and periosteum respectively and continuing by a stem on each side of the middle line towards the vertebral foramen. The excavation disappears during the second year of life, except in the fifth to seventh dorsal vertebrae and in the first and second lumbar where it remains up to the age of fourteen. From the excavation there is occasionally seen running through the middle of the vertebral body toward the vertebral foramen a strip 1 to 2 mm. wide, slightly ossified and having the appearance of a canal. In other cases a similar canal is seen only in the center of the vertebra and running but a few millimeters in the same direction. These canal formations assume different forms during the age period two to fourteen.

In some individuals the vertebral body has a stairstep like outline at its two anterior corners. The epiphyses are formed in these step-like formations. The author has found this type of vertebra in individuals with rounded backs and assumes that this peculiar shape of the vertebrae may be the anatomical foundation in some cases of kyphosis. The epiphyses have been stated not to appear before the age of eleven, but the author has found a case in a child aged six.

Since in the author's experience the above described canal formations are present in all cases (in fetuses of 35 cm. length and in individuals up to the age of fourteen) and since these canals are largest in those vertebrae that are generally the seat of tuberculosis, it is assumed that the extensive venous system of these vertebrae may contribute to the retention of tubercle bacilli should there be an invasion.

HAUPT, WALTHER. The technique of the roentgen treatment of uterus carcinoma. *Strahlentherapie*, 1925, xxi, 132–139.

A description is given of an installation which may be applied to any apparatus and permits sufficently accurate pointing of the primary beam upon the cervix uteri. The method necessitates but one entrance into the vagina for all fields. Moreover, the instrument permits the skin fields without repeated insertions.

The device consists of a semicircular metal bar, the diameter of which is about 50 cm. At the two ends are screws 15 cm. long pointing toward the center. These screws are employed in adjusting the metal semicircle to different body thicknesses and for exactly centering the apparatus over the area to be irradiated. By directing the roentgen-ray beam along any radius upon this semicircular device the dose may be centered over the desired area and through as many portals as may be necessary.

HEIDENHAIN, L. The problem of roentgen dosage. *Strahlentherapie*, 1925, xxi, 96–109.

It is becoming more and more clear that many controversies in the field of roentgen therapy find their origins in misconceptions regarding dosage. It has been urged by a number of workers that the reason their successful results cannot be duplicated elsewhere is the

fact that the prescribed dosage has not been reproduced. Moreover, the experience of the author in the past few years has clearly demonstrated that apparently slight differences in radiation dose may produce a successful outcome or complete failure.

One of the first steps necessary toward a clarification of the situation is the adherence by all to the newly adopted unit of measurement of roentgen radiation, the "R." This is a necessary prerequisite. It is recommended that the dosage reported be that which is measured in the primary beam of rays rather than the R value measured in the patient. The time required for the delivery of any desired dose can be calculated from the calibration value of the roentgen apparatus.

Uniformity in dosage cannot be attained if one worker reports a depth dose measured in R units within the body of the patient and another worker derives his value from a relative measurement in a phantom and reports his dose as percentage of the surface dose. Since measurement of the R value in the depth or a comparison of the surface and depth measurements is possible only in the vagina and in the colon it seems advisable, in general, to state the effective quantity of energy reaching the depth in hundredths of that reaching the surface according to some relative figure, that is, as heretofore by comparison of the discharge periods of the indicator in the measuring instrument. This procedure is justifiable for the reason that it is only the dose of primary rays administered which is effective in the deep layers. The fact that this dose is altered at the surface and in the depth and is multiplied through recoil and secondary irradiation to a different degree at the surface than in the depth is of no significance in therapeutic practice. The determination of the quantity of radiation (m per cent) which actually reaches the depth is completely adequate. It is absolutely necessary to keep in mind that the m per cent radiation which actually reaches the depth is not m per cent of the primary radiation but m per cent of the radiation effective at the surface, and when R units of primary radiation are delivered, its value is $n \times zR$ units on account of recoil radiation which augments it, where n is a variable factor.

The author regards the primary radiation as the actual dose in the same sense as in drug medication the quantity of drug administered to the patient is considered the dose, and effects or changes produced after the drug is taken are secondary matters. The internist is primarily interested in the original dose and has less interest in the changes undergone by the drug inside the body.

HERRING, JOHN A. Cooling the developer. *Radiology*, May, 1926, vi, 431–432.

The author suggests the elimination of the uncertainties incident to ice man service by the use of an electrical refrigerating device such as the "Frigidair" ice cream cooler. The cooler is placed in a large master tank, and the developer and fixing baths are set into the master tank which is filled with water. The refrigerating apparatus is set into action until the temperature is down to 65° when it is turned off.

HERZ, RICHARD. The hardness and intensity distribution of scattered roentgen rays. *Strahlentherapie*, 1925, xxi, 110–131.

In order to obtain a favorable relation between absorption and scattering of the rays the author employed a spectrally condensed beam. This mixture of rays was produced at a potential of about 55 kv. effective, filtered through 4 mm. Al. These conditions produced a satisfactory homogeneity as was demonstrated by the electroscope. The beam was examined spectrographically and showed a limiting wave length of $\lambda_0 = 0.15$ A. A table is given showing the results of the measurements with a primary beam of λ (effective) = 0.395 A. This wave length was obtained with the aid of the experimentally determined coefficient of mass decrease from the Richtmyer equation. The wave lengths of scattered rays found at different angles are listed and compared with the values derived from the Debye equation. A comparison is also given of the wave lengths with those found in Comptom's measurements for uniform scattering bodies. The values determined experimentally by the author show that the change in wave length with increasing angle of scattering remains a few per cent below the values required by theory. This divergence is due to the fact that the Richtmyer coefficient represents an average value. Technical difficulties did not permit measurements with monochromatic radiation.

Closely approximate values for the intensity distribution of filtered and unfiltered scattered rays were obtained by exposing films for definite periods and calculating the values according to a previously calibrated scale. The results obtained are compared with those of Thomson, of Friedrich and Bender, and of Barkla and Ayres. The values are in good agreement between 60 and 120°. The intensity upon the incident side is not very much different from that on the exit side. The data do not take into account absorption in the spherical layer which may possibly be responsible for a certain asymmetry in the distribution of intensities.

From the above and certain theoretical considerations the author presents calculations of the scattered radiation energy at different angles for various voltages between 100 and 1000 kv. Similar values are also presented for the recoil electron energy. Calculation shows that the proportion of recoil electron energy to total scattered radiation energy is 14.8 per cent at 100 kv. and 52.6 per cent at 1000 kv.

These matters are of more than theoretical interest since it seems agreed that the biological effect of a radiation is produced by the electrons set free. For instance, calculation shows that with radiation produced at 150 kv. maximum, about 14 per cent of the total scattered energy is transformed into recoil electron energy; and when 200 kv. maximum is employed the recoil electron energy mounts up to about 25 per cent. At 150 kv. the photoelectrons predominate over the recoil electrons, while at 200 kv. the situation is reversed. And with still harder primary rays (gamma radiation) the recoil electrons play the dominating rôle in the biological effect. It is suggested that the factor of interest to the roentgen therapist is not so much the per cent intensity of roentgen energy at different depths but rather the ratio of the effective photo- and recoil electrons to surface energy.

HERZOG, R. O. Roentgen-spectrographic comparison of lichenin and cellulose. *Ztschr. f. physiol. Chem.*, 1926, clii, 119–124.

The roentgen diffraction patterns of beta cellulose and lichenin are similar but not identical. It may therefore be assumed that these substances are chemically related and that the main crystalline component is identical in both. There is roentgen spectrographic evidence that native cellulose is a secondary product of the organism.

HOLZKNECHT. Protection of the vicinity of irradiated fields in roentgen treatment. Luminescent lead. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, January, 1926, xxxiv, 169–171.

The author has discarded the use of heavy lead sheets and similar devices and has gone over to the use of medium lead strips about 20 × 8 cm. which are attached to each other by clips so as to outline the field to be exposed. The lead is sufficiently flexible to be adjusted to the surface. The housing of the roentgen tube is so fixed that the outlet for the rays can be adjusted by two sliding shutters moving at right angles to each other. Care is taken to have the cone of rays such as to completely inclose and completely cover the field intended but not to extend beyond the lead circle.

In order to make sure that the cone of rays does not encroach beyond the limits intended use is made of a luminescent warning. A flat strip of wood 40 cm. long and 25 × 5 mm. cross section has fixed at one end a piece of fluorescent screen or fluorescent film. This is moved around the irradiated zone to make sure that the radiation is admitted only where wanted. Where large lead strips are employed for large fields these pieces of fluorescent screen are distributed at the edges of the field. A description is also given of the use of "luminescent lead" which was specially devised so as to give sufficient light to be detectable by the eye yet not to have excessive afterglow. The fluorescent material, which is elastic, washable, and sterilizable, is contained in a coating which is fixed to the lead surface.

HOLZKNECHT, GUIDO. Special training for physicians in roentgenology. *Radiology*, March, 1926, vi, 181–186.

The question as to how and in what institutions systematic instruction in roentgenology is to be organized and developed still awaits a definite solution. At present the apprentice system is very much in vogue. Undergraduate instruction has been partially worked out, at least to the extent that suitable medical representatives of general roentgenology, employing a method partly systematic and partly clinical, endeavor to impart the fundamental principles of the specialty, while purely clinical lectures are relied on to enlighten the student in certain special types of roentgenology. The first and more fundamental part of the instruction of students is given thus far by the medical faculties of only the more enterprising, newer and smaller nations, whereas the more formal types of medical schools have not yet introduced it.

The special training for physicians is still entirely unorganized and very inefficient. The quality of instruction is defective, yet because of the undeniable practical need, there are abundant opportunities for securing the instruction. The causes for the negative results of the special training given physicians in roentgenology may be summed up as follows: (1) the inadequate length of apprenticeship; (2) the giving of instruction in the practical applications before the fundamental principles have been mastered; (3) lack of coherence in the didactic methods employed owing to the undue division of the subject into its branches; (4) the group courses organized to counteract the defects due to lack of coherence; (5) no variation in method to meet the needs of individual physicians whose previous trainings differ widely, and (6) attempts to give special training

to physicians who have had no practical medical experience.

To correct the above difficulties has been the aim of the author during the past twenty years. Pupils who are being trained in the roentgenology of a specialty are made to spend half of their training period in studying the principles of general roentgenology. The theoretical question as to whether roentgenology deserves to be recognized as a specialty is not yet decided; from the practical standpoint the question is settled in the affirmative. For the present the training in general roentgenology must be given in the central laboratories of the large hospitals, having no or only slight connection with the universities. Thus, the way for newer developments will be prepared and the practical needs met. The roentgenologist must be well trained in general medicine and the best practical results are exhibited by the group of assistant physicians of large hospitals who during the four-year period of service have received compulsory systematic training in all the branches of medicine.

The main basis for a subdivision for work in the roentgenologic department is the distinction between plate diagnosis and roentgenoscopic diagnosis and therapy, which is due to differences in technique. It separates, at the same time, from the diagnostic standpoint, those with a surgical bent from those whose chief interest lies in internal medicine. The four essential forms of instruction employed in the special training in roentgenology given physicians should consist of textbook study, practical laboratory work, lecture courses and seminar. No absolutely fixed schedule is followed but the work is adjusted according to the attainments of each individual. Short courses are to be refused except for advanced students, and the longer courses permit an adequate preparation of the individual. The instruction is given by the heads of the two main roentgenological divisions and by the specialists working in the roentgenological institute.

The pivotal point in this scheme of instruction is the initial examination of the pupil as to his capacity and previous training, followed by an effort to plan the course so as to meet the individual's needs.

Jaubert de Beaujeu, A. The elasticity and tonicity of the stomach. *J. de radiol. et d'electrol., Par.*, May, 1926, x, 193–209.

A roentgen study was made of the normal stomach with the subjects standing and lying down. A number of roentgenograms illustrating the findings are given. The author concludes that the word tonicity should be used in its etymological sense, which gives an idea of tension and not of contraction. He thinks that tonicity is the physiological elasticity of a muscle or system of muscles. It is regulated by the sympathetic nervous system, nutrition and circulation. Tonicity is only the physical elasticity of living muscle under given physiological conditions; it is totally different from contractility. If the word tonicity is to be applied to contractile organs the writer should specify that he is speaking of contractile tonus and not of plastic tonus.

The stomach elongates under the influence of the hydrostatic pressure of the liquids which it contains. Measurement of the amount of elongation and observation of the position of the stomach in dorsal decubitus gives information as to the tonicity, or actual physiological elasticity of the stomach. This study was made from an experimental and physiological point of view. It should be taken up again with the collaboration of a physiologist to examine the relations existing between retraction and elongation on the one hand and general diseases and diseases of the stomach on the other.

Jerman, E. C. Extremity technic. *Radiology*, March, 1926, vi, 252–254

Two tables are presented as a guide in the roentgenography of the extremities. The first requirement is a calibration chart for the instrument from which can be read off the autotransformer or pre-reading voltages corresponding to the indicated kilovolts peak.

A 36 inch distance is suggested in order to place the high tension line far away from the patient, to bring about better detail and to provide a longer exposure time. A 5 sec. exposure may be more readily and accurately duplicated than a 1 sec. or smaller exposure time, especially if an accurate time switch is not available. A 25 inch distance is suggested when no screens are used in order to avoid employment of the higher gap or voltage or of a prolonged exposure time. To obtain finer detail with the use of a smaller focal spot of the five–ten radiator tube, a 10 ma. technique is suggested; 20 and 30 ma. may be used with the five-thirty radiator tube or the fine focus universal tube.

To use the 100 ma. tube with 0.1 sec. exposure satisfactorily, an accurate time switch becomes a necessity and a stabilizer adds much towards duplication of the milliamperage. The five–ten radiator tube should be used only with the 10 ma. technique; and the five–thirty radiator tube or the fine focus universal tube may be used with the 10, 20, 30 or 100 ma. technique for extremity work.

JERMAN, E. C. Potter-Bucky diaphragm technic. *Radiology*, April, 1926, vi, 336–338.

Following proper calibration of the equipment a chart should be prepared for the various regions and positions of the body with which it may be desirable to use the diaphragm. A table is presented for a normal medium sized adult as a guide in the charting process.

It is suggested that the time of exposure be made the variable factor in diaphragm work when using the 10, 20 and 30 ma. technique, in order to avoid the danger of exceeding the 87 kv. peak which is the limit of both the 5–10 and 5–30 radiator tubes. A given pre-reading or autotransformer voltage may have one value with one equipment and another value with another equipment, consequently the pre-reading voltage required to produce a given kv. peak value must be worked out with each individual equipment with the sphere gap.

For kidney and gall-bladder work where the maximum of soft tissue differentiation is desired with as nearly as possible absolute immobility of the part, and for stomach and colon work where a short time is advisable in order to avoid involuntary movement, the 100 ma. technique with its corresponding shorter exposure time and lower kv. peak is suggested. The 100 ma. technique requires the use of an accurate time switch and will be more accurately duplicated by the use of a stabilizer. The 5–10 radiator or the medium focus universal tube should be used for all 100 ma. work with the diaphragm. The 20 and 30 ma. techniques are advisable when on account of the condition of the patient it becomes necessary to sacrifice detail for a shorter exposure. Where the time of exposure exceeds 30 sec., such as with lateral lumbar spines in larger patients, the exposure should be made in two or more relays.

JERMAN, E. C. One hundred milliampere, three-tenths of a second technic. *Radiology*, May, 1926, vi, 426–428.

A chart is presented (based upon the average adult of 150 pounds) giving details of roentgenographic technique with the tube operated at 100 ma. for $^3/_{10}$ of a second. A medium focus universal tube may be used in place of the 5–100 tube. Details are given of the technique in roentgenographing the gall-bladder, the stomach and colon and the lateral cervical spine. For the gall-bladder the position is posteroanterior, and the skin focal distance is 22 inches, with the tube operated at 76 kv. peak. The stomach and colon are roentgenographed in the posteroanterior position at a skin focal distance of 25 inches with the tube operated at 84 kv. peak. The cervical spine is taken at a distance of 6 feet with the tube at 92 kv. peak. An accurate time switch is necessary in order that the exposures may be duplicated, and a Bucky diaphragm is not used because of the difficulty of making fractional second exposures with it.

LAHEY, FRANK H. Indications for surgical treatment of goiter. *Radiology*, May, 1926, vi, 368–371.

When malignant degeneration of a thyroid adenoma is diagnosable, it is hopeless surgically. It is here that the author has seen some of the very best results in a palliative way from roentgen treatment. A large number of intrathoracic goiters are located either to one side or the other of the trachea resulting in the deviation of that structure, usually in a curve corresponding to the more or less spherical outline of the adenomatous masses, the roentgenographic demonstration of which is of marked usefulness in the diagnosis of this condition.

The characteristic features of the roentgen picture of intrathoracic goiter are the sharpness of outline of the intrathoracic mass due to the fact that such masses are usually symmetrical in shape in a firm fibrous capsule surrounding. It should be a fixed rule that every nodular goiter be carefully roentgenographed for detecting the possible presence of an intrathoracic mass. All intrathoracic goiters are surgical and should be removed. The author has several times been unable to demonstrate intrathoracic masses roentgenographically but at operation found such masses extending well down into the mediastinum. This is regarded as one of the distinct advantages of the operative procedure done on thyroids for other indications such as toxicity.

Patients have been so often seen to die as the result of deferred and inadequate treatment that the author has arrived definitely at the conclusion that the best form of treatment for a condition as serious as thyroidism is the one which most quickly, most certainly, most completely and most permanently relieves the toxicity, and that is surgery.

LAWSON, R. W. The energy liberated by radium. *Nature*, 1925, cxvi, 897–898.

One gram of radium, free from its disintegration products is calculated to liberate 23.28 or 25.47 calories per hour, according as the number of atoms of radium disintegrating per second per gram of element is taken to be 3.40 or 3.72×10^{10}, respectively. The value obtained experimentally by Hess is 25.2 calories per hour, but when account is taken of the amount of gamma radiation unabsorbed under the experimental conditions employed, it is computed that the corrected value cannot

greatly differ from 25.5 calories per hour. This is regarded as corroboration of the above value of 3.72×10^{10}, as the true figure for the number of atoms disintegrating per second in one gram of radium element.

LINDBLOM, ADOLF F. On the effect of lipiodol on the meninges. *Acta radiol.*, March 15, 1926, v, 129–134.

Lipiodol injected subdurally into rabbits in comparatively large quantities (1 c.c.) gives rise to acute leptomeningitis that soon subsides. In only one out of 7 animals has this meningitis had a fatal end. Histologically, there results an abundance of cell infiltration in the meninges mainly consisting of leucocytes. Subsidence takes place in a few weeks after which no changes can be seen despite the presence of large quantities of the oil *in situ*. The cells in the pia are able to absorb lipiodol, but the process seems a very slow one.

Preliminary observations in human cases show that after intralumbar injection of 5 to 10 c.c. of lipiodol, acute leptomeningitis develops with marked increase of cells in the lumbar fluid (exclusively lymphocytes). The meningeal symptoms were observed to subside within two weeks after the injection. The magnitude of the dose seemed in no way related to the intensity of the inflammatory reaction which reached a maximum from the third to sixth day after injection.

LINSBAUER, K. Roentgenological studies on mosses and ferns. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, January, 1926, xxxiv, 25–48.

Experiments on the liverwort (*Fegatella conica*) and its spores show complete insusceptibility to roentgen-ray doses up to 40 H for the spores and the early developmental stages. On the other hand, a dose of 2 H or more causes increasing arrest of growth in the growing liverwort thallus, but never any appearance of necrosis. By irradiation of the thallus during the stage of winter rest, similar effects are obtained when growth is again initiated.

Fern spores also show themselves resistant to roentgen rays at first but they become susceptible before germination. The experiments also appear to prove that a series of doses administered during the period of latency have a summative effect.

Another effect produced by the irradiations is the alteration in the type of growth of the prothallium. Intense irradiation appears to hinder the development of the normal growing point. There is a tendency for pronounced branching or overlapping which is explained as due to retardation of development of the vegetative center resulting in a marked proliferative activity.

LYSHOLM, ERIK. A magnifying stereoscope. *Acta radiol.*, Jan. 15, 1926, v, 109–111.

The author uses an ordinary Zeiss field glass and attachable lenses both for uniocular enlargements and for stereoscopic enlargements in the study of roentgen films. Low magnifications are preferred in the stereoscopic study of the sinuses and the mastoid process. Greater enlargements have proven useful in the study of changes in the bone system.

MCHUTCHISON, JOHN P., and BROWN, W. HERBERT. A new development in radium therapy. *Lancet*, April 10, 1926, i, 755–758.

The radio-elements, radium D and radium E, have been extracted from used radium emanation tubes, and in equilibrium together have been prepared for medical use in the form of different kinds. (Radium D has a half life period of sixteen years and radium E a half life period of 4.9 days.) Such applicators have been found to exert a beneficial action in the treatment of lupus erythematosus and of various types of nevi. Conditions like eczema and psoriasis will also respond, but it has not been found convenient to treat large affected areas by means of applicators.

The radiation from radium D and radium E has the unique property so far as radium treatment of skin conditions is concerned in that it is all absorbed by the part being treated, since its effective penetration is only about 3 mm. of tissue. Radium D and E applicators retain their strength and may be used for many years. Radium D and radium E emit both beta and gamma rays, but unlike those from radium B and C these are soft and possess little penetrative power.

The applicators were of such strength as to produce a mild erythematous reaction after fourteen days' exposure. There is evidence that stronger applicators may be still more valuable. In every case the applicator was removed after a decided reaction was produced, and if necessary was applied to the same area in about four to six weeks, after all trace of the previous reaction had disappeared. Occasionally a slight blistering was produced. The authors' experience indicates that this blistering should be avoided. Good results are likely to be obtained if the applicator is worn only long enough to produce a mild erythema. Six cases are briefly cited. The results of treatment are considered very encouraging.

There is also given a description of the methods for extracting the radium D and radium E, the preparation of the applicators by

(1) precipitation and adsorption methods; (2) electrolytic methods, and (3) replacement methods.

MARINO, SLAVATOR, and MILANI, EUGENIO. Biochemical changes in the blood on irradiation of the suprarenals. *Arch. di radiol.*, Mar.–June, 1926, ii, 209–228.

The authors irradiated the suprarenals of animals and of normal and obese human subjects with varying doses of roentgen rays in order to determine the effects of irradiation on the blood. While the authors who have studied the subject before have limited their investigations to blood sugar and adrenalin, Marino and Milani also determined total fatty acids and cholesterin.

The comparative study of the various substances in the blood showed that the chief action of the roentgen rays is on the cortex of the suprarenals: the great increase in cholesterin in comparison with adrenalin is a direct proof of this. On irradiation of the suprarenals in animals or man, whatever the dose used, there is always a considerable increase in adrenalin, cholesterin and fatty acids in the blood, and the increase is particularly marked for fatty acids and cholesterin. The increase does not begin immediately after the irradiation, but generally begins within twenty-four hours, reaches its maximum on the fourth to fifth day and may then persist for fifteen to twenty days. Pozzi found the same behavior of the pressure curve, independent of the dosage; the curve showed two increases, one on the fourth to fifth day and one on the twentieth day, the latter chiefly when the irradiation was of the stimulating type.

There was always an increase in the adrenalin content of the irradiated suprarenal capsule, both while the animal was still in a condition of hyperadrenalinemia and after the blood adrenalin had returned to normal. The quantity of adrenalin in the capsules therefore cannot be taken as an evidence of a stimulating action of the rays, since the capsule, evidently changed by the irradiation, may be rich in adrenalin while the reaction in the blood is negative. The chromaffin reaction is not always parallel with the amount of adrenalin.

The variations in blood sugar were not especially characteristic. In general, for the first few hours after the irradiation there was a tendency to increase, especially in the animals; then, with slight oscillations which remained within normal limits, the amount returned to its original values. These variations in glycemia, at least in the animals and the normal human subjects, seemed to be relatively slight in proportion to the regulatory action of the suprarenals; they are perhaps due chiefly, under normal conditions, to physico-chemical changes in the cells under the action of irradiation. But the increase in adrenalin and particularly in cholesterin and fatty acids seems to be intimately connected with suprarenal function.

They did not obtain sufficient evidence to differentiate between the reaction to a stimulating dose and a destructive one except that the increases brought about, which in general seem to be due to hyperfunction of the suprarenals, were slighter and less persistent with the stimulating doses, with a more or less rapid return to normal and without the last increase toward the twentieth day which was seen with larger doses. With large doses if the animal was not killed his condition grew worse and he finally died, while with small doses he gradually improved after the twentieth to twenty-fifth day and finally regained his normal condition.

MEYER, WILLIAM H., and GLASSER, OTTO. Erythema doses in absolute units. *Radiology*, April, 1926, vi, 320–328.

The methods of dose estimation supplemented by numerous tests with ionization made it possible to translate quite accurately previous erythema units in terms of E or R units. The d^1_2 value layer formed the basis for determining the quality. In addition to various intensity measurements, a definite skin reaction was sought in all cases where such procedure was permissible or justifiable. The total range of an erythema dose appears to extend over about 100 per cent from minimum to maximum; that is, from a faint blush up to a point just short of vesiculation or denudation. It would be most logical to select as a unit dose the minimal dose with which a reaction occurs in the maximum number of individuals. With hard rays this occurs in the vicinity of 1300R units.

The results of a series of investigations show that the roentgen-ray quantities, measured in R units, which are necessary to produce the same biological reaction on the human skin vary markedly with the quality of radiation administered. The number of R units per erythema decreases with increasing wave length; restated in another way, the number of R units increases with increase of the half value layer, i. e. with increasing hardening of the rays. A curve is presented showing the relation between the R units necessary to produce a standard skin reaction with varying ray qualities.

The erythema doses in R units referred to above were given at one sitting. Fractional doses would introduce a new factor, namely, the cumulative effect of the rays, resulting in an increase in the number of R units when divided dosage is employed.

Mutscheller, A. Further studies on physical standards of protection against roentgen-ray dangers. *Radiology*, April, 1926, vi, 314–319.

A special type of ionization chamber and electroscope was designed for estimating the total quantity of radiation which might potentially be capable of causing injury to operators. The calibration of the instrument was made by measuring its electrostatic capacity and its voltage sensitivity in the usual manner.

From the standpoint of protection of the operator, it is of the greatest importance to know exactly the dose of radiation which he receives either from the patient's body or from nearby objects exposed to the rays. A number of objects were exposed at an angle of 45° to the rays from a uniform potential machine producing a minimum wave length of 0.056 A. These rays were filtered through 0.58 mm. Cu. The area exposed 24 inches from the target was 97.8 sq. cm. The ionization chamber was carefully shielded against direct rays and was placed 23 inches from the center of the irradiated area at an angle of 90° to the direction of the primary beam. When one erythema dose of radiation (1300 R) is delivered to surfaces of iron, brass, copper, lead, aluminum, bakelite, or birchwood, the secondary radiation given off under the conditions of the above experiment was between 5.4 and 10.4 per cent of the incident dose.

If we assume the tube to be completely surrounded with a lead drum 5.6 cm. thick and the tube operated at 4 ma., 200 kv. for ten hours daily, then at 50 cm. distance and in one month's time a patient would receive about 106 erythema doses; and through the leaded drum at a distance of 10 feet the operator would receive about $\frac{1}{100}$ of the erythema dose. In addition, if we also assume that an area of about 100 sq. cm. is exposed on the patient then from this area there would be obtained in addition a little over 4 erythema doses. In other words, the operator is exposed to a considerable hazard from secondary rays under these conditions.

For practical and clinical purposes the intensity of secondary radiation depends and varies as the area exposed on the patient or on the scattering material. Doubling the area doubles the intensity of the secondary radiation and so on.

The above calculations are based on an almost perfectly shielded roentgen tube. It is obvious that if the tube is not completely surrounded with protective material, scattered radiation not only from the patient but from surrounding objects and walls of the therapy room would mount up considerably for the patient as well as for the operator.

The factors which enter into the making up of the final total dose to the patient can be summarized in the equation

$$\frac{E_p \times S \times F}{d^2} = E_s$$

where E_p is the primary erythema dose administered, E_s the erythema doses of secondary radiation formed and S the area of the exposed surface in square centimeters. F is a factor characteristic for the material from which the scattering is produced, and the values for this factor are given in a table in the original paper.

Various installations were compared with respect to secondary radiation doses to which on the one hand the patient is exposed and against which on the other hand the operator must be protected.

Opitz, Erich. Regarding Dessauer's hypothesis of heat points. *Strahlentherapie*, 1926, xxi, 444–446.

According to Dessauer, the primary waves or secondary beta rays when they strike an atom produce a considerable amount of heat in vanishingly small areas. These points of heat distribute themselves rapidly, and as a consequence the total temperature rise in the irradiated body is practically immensurable. However, at these points according to Dessauer, the heat generated exceeds that of the heat of evaporation of water, may even reach 200 or 300°C., and is at any rate sufficient to coagulate protein molecules in its vicinity and lead to the denaturing of all the cell protein.

According to the author, if this is true, then it should be susceptible to test with those substances having a low flash temperature and a rapid reaction velocity, analogous to the case of sparks in a charge of powder. Tests were made with pure yellow phosphorus which has a flash temperature of 60°C. and with gun cotton which explodes at 183 to 186°C. A small piece of the phosphorus in a test tube was exposed at 10 cm. distance from a roentgen tube and was irradiated for 15 minutes with both hard and soft rays, filtered and unfiltered. There was interposed between the phosphorus and the roentgen tube a handkerchief for protecting the roentgen tube in the event of a flash. The phosphorus remained unchanged. The gun cotton (nitrocellulose) was treated in the same way without any sign of a response to the irradiation. This would seem to disprove the heat point hypothesis, for if local temperature of 200°C. were generated by the rays, both substances would have ignited or exploded.

POHLE, ERNST A. Studies of the roentgen erythema of the human skin. 1. Skin capillary changes after exposure to unfiltered radiation. *Radiology*, March, 1926, vi, 236–254.

The study of the capillaries of the human skin with the skin microscope shows a great variation of their appearance in normal individuals and in different parts of the body. After exposure to 0.5–1.0 skin unit dose of unfiltered roentgen radiation very characteristic changes occur in the skin capillaries as has been noted by other investigators. Complete *restitutio ad integrum* takes place in from one to three months.

The capillary changes run almost parallel to the visible erythema; the latter developing in several cycles or periods as described by Miescher.

The data presented by the author were obtained from an observation of 12 normal adults (8 males and 4 females). The upper flexor side of the forearm was studied with a capillary microscope before and after irradiation. The rays were produced with a 9 inch spark gap, 5 ma., 30 cm. focal skin distance, no filter. The capillaries were studied 6, 24, 48 and 72 hours after exposure and so on, daily, until the erythema disappeared, then once a week over a period of from four weeks to three months. The findings were confirmed by examinations of over 100 patients.

RAJEWSKY, B. The problem of dosage of roentgen rays. Standardization of dose measurement. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, January, 1926, xxxiv, 62–80.

The roentgen rays necessary for practical purposes must be calibrated. Their spectral composition can be given by the standard measurements of kilovolts, μ (coefficient of decrease) and the minimum homogenizing filter. The ray distribution should be standardized by the photographic method, taking into consideration the practical requirements. Biologically determined doses must be measured and calibrated in terms of physical units. The unit for radiation measurements should be the quantity of radiation given under standard conditions by 1 gm. of radium element in one second. It will be the problem of physical research to establish the standard conditions and the quantity of energy of the unit in absolute units.

Independently of this there should be available a provisional unit easily produced and reproduced, which will utilize one of the definite and reliable effects of radiation (for instance, ionization) for important practical purposes. Thus 1 R would be that quantity of radiation energy which at normal temperature, pressure and standard chamber construction produces the same ionization as 1 gm. of radium element in 1 sec. with standard filtration and location with respect to the ionization chamber. Provisonally this unit need not correspond to the actual magnitude. Strictly speaking, it would only represent the effect of the rays, which is taken as an indicator and which is accepted until we shall find means for translating the "effect" in terms of energy or until we discover a method for direct measurement of the number of radiation quanta. The measuring instrument that will eventually be employed is the Glasser air-wall chamber and the conditions of measurement (position of chamber, etc.) will naturally have to be standardized. Adherence to the principles above outlined will lead to the normal development of the standardization of dose measurements.

The various aspects of dosimetry are summarized and a list of 61 references is appended.

REISER, EGON. Process of producing photographs of roentgenological observations. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, January, 1926, xxxiv, 80–83.

Photography of the shadows on the roentgenoscopic screen is the procedure suggested by the author. By the employment of blue screens the exposure time necessary is reduced to practical limits. The photographic plate is protected from the roentgen apparatus and the image from the screen is reflected by means of a mirror to the photographic plate. By warming the fluorescent screen the after-glow is diminished.

This procedure was suggested by Biesalski in 1909, who proposed the use of concave mirrors so as to concentrate the effect of the weak screen fluorescence. While this method will hardly ever fully replace the roentgenographic picture its utility may commend itself for purposes where cheap superficial photographs suffice.

ROGERS, F. T., and MARTIN, C. L. *X*-ray observations of hunger contractions in man. *Am. J. Physiol.*, April 1, 1926, lxxvi, 349–353.

If a thin rubber balloon is introduced into the stomach and slightly distended with air, as is used in the graphic differentiation of shadow density to make the outline of the fasting stomach visible in the roentgenogram.

The Type 1 hunger contractions of Carlson's classification were observed to be essentially strong circular contractions of the lower half of the stomach, involving particularly a band of muscle near the juncture of the middle and lower thirds of the stomach. This type of

hunger contraction may or may not be associated with active peristalsis. Type III contractions consist of active peristaltic waves running over a hypertonic stomach.

The above observations was made on one of the authors as subject who underwent a fast of eighteen hours followed by a three mile walk, after which the roentgenograms were taken.

SIEVERT, ROLF M. Some studies on the intensity distribution in the customary distance treatments at the Radium Hemmet. *Acta radiol.*, March 15, 1926, v, 217–222.

The distribution of intensity around an apparatus for distant radium therapy was measured by an ionization method. Study was also made of the absorption of gamma rays by the lead protector of the apparatus, the efficiency of a secondary filter, and the distribution of gamma-ray intensity with increasing depth under the skin. These studies were made upon the "radium cannon," an apparatus for production of a narrow beam of rays in treatment by radium at a distance.

The lead walls of the "cannon" were shown to have an effect in diverting some of the gamma rays in the direction of the axis of the beam. The efficiency of a secondary filter in removing beta rays was found to be high. These measurements also disclosed the presence of a certain amount of secondary rays originating in the walls of the lead cylinder. Curves are given showing that an increase of the radium skin distance results in a more favorable distribution of depth dose; but this involves too great an increase in the time of treatment to be useful practically. A distance of 5 cm. has been determined as the most suitable for general purposes. For surface intensity the various radium skin distances may be calculated within 5 to 10 per cent by the inverse square law.

WALTER, B. Secondary cathode radiation from gaseous and gas-free roentgen tubes. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, January, 1926, XXXIV, 129–141.

A description is given of the emission properties and effects of secondary cathode rays from roentgen tubes. These rays emitted from the anode of the gaseous roentgen tube have been known for some time but their production from the vaccum tubes has hitherto not been definitely demonstrated. The author proves their existence partly from his own experiments and partly from the reports published by Coolidge.

These secondary cathode rays emitted from the roentgen tube are due to those small portions of the primary beam of cathode rays which are not transformed into roentgen rays at the anticathode but which manage to pass through the atoms of the anticathode metal unaltered in quality, *i.e.*, electrically charged particles. Electrostatic attraction and repulsion scatters these particles in every direction.

WETTERSTRAND, G. A. A roentgen accident with a fatal result through the short-circuiting of the secondary current. *Acta radiol.*, Jan. 15, 1926, v, 105–108.

An imprudent manipulation of roentgen apparatus cost the life of a doctor and a nurse in an accident occurring at the Mänttä Works, Finland, in October, 1924. No flaws were found in the installation or the earth connection. The two victims were completely inexperienced in the simplest principles of electricity as related to roentgenology. The doctor was handling the apparatus for the first time. The high tension current had been switched on and the doctor approached the roentgen tube, placed his right hand near the neck of the cathode, with the intention of centering the tube. The nurse was standing close to him and had put her left hand near the region of the anode, probably with the intention of assisting in centering. There resulted a coupling in series parallel with the roentgen circuit and the high tension current passed through the bodies of the two victims, jumping the slight air gap between them. The author emphasizes that despite all precautions no apparatus can be rendered so utterly safe as to prevent accidents to ignorant or untrained persons who attempt manipulation of the apparatus.

ZIMMERN, A. Spectrography of roentgen rays. *J. de radiol. et d'électrol.* June, 1926, x, 241–254.

There are many things in the nature of roentgen rays which tend to identify them with electro-magnetic waves. The discovery of interference proved their undulatory nature beyond question.

The undulatory nature of light is shown in optics by the phenomena of interference brought about by gratings, that is a series of fine lines drawn very close together on a glass plate. The best glass gratings have 500 to 1000 lines to the millimeter. A ray of monochromatic light passing through a narrow fissure and falling on such a grating throws on a parallel screen a series of linear images of the fissure, all at equal angular distances, the size of the angle depending on the length of the light wave. The total of these images constitutes the diffraction spectrum. The number of lines to the millimeter of the grating being known and the angular distance of the linear images it is possible to calculate the length of the light wave.

But the roentgen wave is so many times shorter than the light wave that it is impossible to make gratings mechanically which would reveal phenomena of diffraction with them. Such gratings exist however in nature in crystals and the work of Laue, a German physician, demonstrated both the undulatory nature of roentgen rays and the reticulate structure of crystals. He passed a narrow bundle of roentgen rays through a crystal of zinc sulphate to a sensitive plate a few centimeters beyond it. Around the direct image of the bundle a multitude of little circular or elliptical spots appeared, distributed regularly around the center of the figure and symmetrical also in intensity of distribution. With different crystals different diagrams were obtained, but always symmetrical in their arrangement. In analogy with those produced by optical gratings these figures were known to be due to diffraction. But Laue's apparatus did not furnish any means of determining the dimensions of the network or measuring the length of the wave. However his work contained the germ of all future work on the spectrography of roentgen rays.

Following up this fundamental idea different forms of spectrograph have been devised. That of Bragg has almost the form of an optical spectroscope, the prism being replaced by the crystal and the ocular by an ionization chamber connected electrically with an electroscope. The method of de Broglie registers the roentgen-ray spectrum photographically and by means of rotation of the crystal by the slow and continuous movement of a clock-work mechanism the registration is automatic. Details of the construction of these and other spectrographs are given, among them that of Seemann which is said to be the one most in use in Germany for medical roentgenology.